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## **CONTENTS**

	<b>Page</b>
<b>Bicycle Accidents and Usage Among Young Adults; A Preliminary Study, by Stuart A. Schupack and Gerald J. Driessen. . . . A 1</b>	
<b>Abstract Citations . . . . .</b>	<b>1</b>



## BICYCLE ACCIDENTS AND USAGE AMONG YOUNG ADULTS; A PRELIMINARY STUDY\*

by

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### Abstract

Data on a broad but not totally representative sample of 1,232 young adults aged 16 to 30 were collected from 27 college campuses representing all nine U.S. Census areas. Information was gathered concerning the bicyclist, the bicycle used, the person's use of the bicycle on last driving day, and accidents occurring in the past five years, with emphasis on those in the past 12 months. The relationship of usage and accident patterns with driver sex and type of bicycle were highlighted. Generally, males and bicycles with five or more gears had more accident occurrences, but fewer accidents per 1,000 miles of exposure. Significant interactions of sex and bicycle type were also found. Usage and exposure differences between accident and no-accident groups were discussed. The accident group had higher mileage and used their bicycles more often, more for transportation than recreation, and in heavier motor vehicle traffic than the no-accident group. Comparisons of these preliminary adult bicyclist data were made with data from earlier studies of children.

### Background

This document represents the fourth major research report on bicycle safety issued by the Research Department of the National Safety Council in the last nine years. Earlier studies were by Vilardo, Nicol, and Heldreth (1968), Vilardo and Andersen (1969), and Chlapecka, Schupack, Planek, Klecka, and Driessen (1975). The rapid increase in the use of bicycles in the United States in the past decade has been sub-

stantial. As one would expect, this increased usage has led to a parallel rise in the number of bicycle accidents. The safety community has been especially concerned about children's bicycle accidents, and consequently much research and program development activity has dealt with this particular problem. Based on some of the aforementioned research, the National Safety Council developed the *All About Bikes* program as a specific countermeasure to help reduce bicycle accidents among elementary school-aged children. This program is currently being used by school systems throughout the country. While adult bicycle driving has undergone an even more dramatic increase in popularity, there has been little research effort spent in examining the usage and accidents of the adult bicyclist. This study is a preliminary step in remedying this oversight.

The primary obstacle to be overcome in examining adult bicycling is the gathering of a suitable sample from which to collect reliable data. Neither bicycles nor bicycle drivers are licensed by official agencies. Most bicycle accidents are not entered in any regular, official reporting system except for the few injury-related motor vehicle involvements. Traffic rules are poorly enforced for bicycle drivers and violations are rarely, if ever, entered on official records. Fuel consumption figures used to estimate automobile mileage are, of course, meaningless for bicyclists. Thus, several of the important sources of information concerning automobile usage and accidents are not available when studying bicycles. The absence of these sources makes it necessary to contact bicyclists directly in order to collect the required data.

The possible methodologies for contacting bicyclists were restricted by both theoretical and financial limi-

\* Partially supported by a grant from Schwinn Bicycle Company, Chicago, Illinois.

itations. First, the study was intentionally restricted to young adults, aged 16 to 30. Second, the authors wished to gather a broad base of general information rather than detailed answers to a few specific questions, since the scarcity of previous research made it difficult to form any specific, testable hypotheses. Third, the level of funding placed limitations on the size of the sample and on the time that could be allowed for data collection.

Two initial methods of collecting data were tried, but proved unsatisfactory. One involved gathering data through cooperating bicycle clubs, and the other consisted of direct interviewing of Chicago area bicyclists. The primary problem with each of these methods was the inability to generate a sample of sufficient size for reliable analysis. While a small amount of data was collected (some 200 cases), our judgment was that any analysis would be foolhardy. Consequently, none of those data are presented in this report. While this need not discourage other researchers from using these methods, the special circumstances associated with this project's initial stages led to data that were not deemed satisfactory from a scientific viewpoint. Kaplan (1975) has just recently published a report on characteristics of the adult bicycle user. The report was published during the same month as the present study.

The third data-gathering method had more favorable results. By circulating questionnaires on college campuses throughout the country under the auspices of a professor or administrator involved in campus bicycling activities, information on over 1,000 subjects was collected. The quality and quantity of these data were sufficient to allow some meaningful analysis, which is presented in this study.

The preliminary nature of this study severely limits its scope. There are two areas in which these limitations are most clearly seen. First, the group of young adult subjects was one of convenience rather than a scientifically selected representative sample, making it difficult, if not impossible, to generalize the results to a larger population. Second, the data were not collected with reference to a specific hypothesis; rather, variables were included that seemed likely to shed some light on adult bicycle usage or accidents. While this approach yields a large amount of univariate descriptive data, previously unavailable, it also makes any multivariate analyses, even simple cross-tabulations, a haphazard process. Considering these two

limitations, any conclusions drawn from this study must be viewed cautiously. The data should be used as aids for further research rather than as facts with immediate program implications.

## Method

### *Survey Design*

Questionnaires were sent to a total of 55 colleges and universities representing each of the nine standard U.S. geographical areas. Schools were selected on the basis of two criteria—geographic location and the availability of a professor or administrator known to be involved in campus bicycling activities. This contact on each campus was requested to oversee the distribution and collection of the survey forms and to return the completed forms to the National Safety Council.

### *Survey Instrument*

The questionnaire (Appendix A) consisted of over 100 items divided into five sections: You, Your Bicycle, Most Recent Bike Use, Bicycle Accidents, and Local Bicycling Conditions. The items were selected partly from an NSC form used to investigate children's bicycle accidents (Reference 1) and included additional variables to help focus on the experience of young adults.

Questions concerning the bicyclists included sex, age, bicycle driving experience, and several measures of exposure. The exposure measures were months of regular bicycle driving, bicycle mileage driving time, and amount of driving on various roadway types. Information on the bicycle included length of time owned, frame size, wheel size, gearing, brake type, handlebar configuration, and maintenance history. Questions concerning the respondent's most recent bicycle use were asked in order to obtain accurate details of the characteristics of a typical bicycle outing. These details included day of the week, time of the day, weather, driving surface, traffic density, type of roadway, and purpose of drive.

Accident details were requested for the most serious accident within the past 12 months, or, if there were none that recent, within the past 5 years. Some of this information concerning the accident paralleled the topics related to most recent bicycle use. Additional accident information was collected on activity and speed before the accident, familiarity with accident location, type of accident, and several items con-

cerning injury severity and treatment. The final section of the questionnaire was concerned with the adequacy of local bicycle routes or lanes.

### **Data Collection**

Standard data collection procedures were given to the campus contacts. The procedures are described in a letter included as Appendix B. In general, it was hoped that the questionnaire would be given to entire classrooms in order to reduce the bias of having only highly interested bicyclists providing information. While the level of compliance with these instructions is not completely known, the general cooperation of the campus contacts and internal evidence to be presented in the results section suggest that this source of bias was indeed reduced.

Questionnaires were distributed in October, 1972. This meant that the experience of the high bicycling summer months would still be fresh in the minds of the respondents. It also meant that much of the reported accident experience would be from home rather than from the college campus—a fact that increases the geographic spread by some unknown amount and makes any generalizations even more problematic.

### **Data Analysis**

The data analyses had three planned phases. The first was to present and discuss the basic information in the form of simple frequency distributions and proportions and involved the first estimates of several previously unknown parameters of young adult bicycling.

The second phase of the analysis involved several calculations and comparisons. Variables concerning months of driving, driving distances, and accidents were combined to calculate accident rates on a "per person" basis and, separately, on a mileage basis. These rates were further examined by sex and type of bicycle. Then the relationship of certain basic explanatory variables (sex, type of bicycle, exposure) to important accident and usage details was explored. This was done with a series of two-way cross-tabulations. The basic statistical tool was chi-square with  $p \leq .05$  as the level of significance. The same basic method was used to explore differences between accident and no-accident groups.

The third phase of the analysis compared the results of these adult data with previous results from a study of children's bicycle accidents and usage. The simi-

larities and differences between the two groups help define needed areas of further research and provide some general direction for young adult bicycle programs and countermeasures.

Data editing was a preliminary step to all of these analyses. Three criteria were used in editing: completeness of information, current age of the respondent and, if accident details were reported, age of the respondent at the time of the accident. Questionnaires with large amounts of missing data were not keypunched. After keypunching, computer editing removed those cases where the respondents were not young adults, defined as aged 16 to 30. Finally, accidents to those respondents in the youngest remaining age group were removed if they occurred more than one year ago. This editing was done to insure that all accident details were indeed about accidents that happened to young adults and not children 11 to 15 years of age. The exposure and usage data of these cases, being based on the most recent bicycle use, were kept and included in all analyses, since all of these people were young adults when providing this information. Analyses were done primarily with the National Safety Council's IBM 1130 computer with some details completed using a Wang 520 programmable calculator.

### **Results**

Survey forms were sent to 55 colleges and universities. Returns were received from 27 schools for a 49% institutional return. Forms were sent in sets of 100 per school. One school received 2 sets, however, so a total of 5,600 forms were distributed. Returns totaled 1,370 or 24% of 5,600. Editing for completeness and age led to a removal of 74 and 64 forms, respectively. The final sample contained 1,232 bicyclists. Responses to all questionnaire items are included in the full technical report available from the National Technical Information Service.<sup>1</sup> Particular variables will often be referred to by both name and number, e.g., Sex (Variable 1), Age (Variable 2), etc. Frequency distributions of the responses were constructed for the total group and for two groups made up of those who reported an accident (A) and those who did not (NA), i.e., "no-accident." The

<sup>1</sup> Bicycle Accidents and Usage Among Young Adults; A Preliminary Study, by Stuart A. Schupack and Gerald J. Driessen. July 1976. 71 pages. PB-256 563. Sold by the National Technical Information Service, Springfield, Va. 22161. Price: \$4.50.

percentages cited in the text for a given variable will not include non-respondents for a particular questionnaire item, usually less than 5% of the total. Not all of the items in the survey form will be discussed in this report, and the reader is urged to obtain the full technical report for information on any specific variable in which he may have a special interest.

*Demographic characteristics of the sample.* Returns were received from colleges in all nine U.S. Census areas. The number of returns from an area ranged from one (New England and Pacific) to five (East North Central and South Atlantic). While the sample cannot be considered strictly representative of the United States, it is important to note the wide geographic distribution of the returns.

The final sample of 1,232 was 62% male (Variable 1). The ages of the subjects were restricted to 16 to 30 years with 52% between 16 and 20, 40% between 21 and 25, and 8% between 26 and 30 (Variable 2). Reflecting the methodology employed, 96% of the sample reported their education (Variable 5) as some college or more.

*Description of bicycle usage.* Variables 20-44 give a general description of the type of bicycles these young adults were driving. The "modal" bicycle was a 10-speed (38%) with a 26" frame (49%) and 26" wheels (51%), hand brakes (64%), regular handlebars (59%), no front light (62%) but a rear reflector (82%), bought new and assembled (56%) 1 to 6 months ago (20%), and not registered with either the city or insurance company (67%). The most common variations were in terms of gears, (28% 1-speed, 26% 3-speed), handlebars (41% drop-style), and length of time owned (17% 1 to 2 years, 16% 5 to 10 years).

Variables 46-64 report on the details of the most recent bicycle use by the respondent. Since this information on most recent use was collected in the month of October, much of it pertains to driving on the college campuses. Almost one-third of the respondents, however, reported their most recent drive (Variable 47) to be more than one month ago, probably indicating summer driving while at home. Over half of the subjects reported that their most recent drive was one week ago or sooner. Weekends accounted for 35% of the last driving days (Variable 46). Bicycle driving was generally done alone (69%), on dry pavement (91%), with moderate to light motor-vehicle traffic (81%), in a residential area (64%). Three-quarters of the respondents drove farther than

one mile, usually driving on the street with the traffic (71%). Most of their bicycle driving was on secondary streets (50%) or main streets (20%). The most common purposes for bicycling were "just for fun" (39%), exercise or health (13%), and commuting (27%). Of all the respondents, 6% reported falling on their most recent driving day.

As mentioned earlier, one potential source of bias was that only highly interested bicyclists would respond to the survey. This appears not to have been the case. When asked if they had driven a bicycle more than 100 miles in 1971, 1972, or 1973 (Variable 7) only 13% of the respondents answered affirmatively to all three years, and 47% did not report driving 100 miles in any of those years. Only 17% of the sample owned and drove more than one bicycle (Variable 19). When asked how many months they regularly drove a bicycle (Variable 8) and how far they drove (Variable 9), 51% of the respondents indicated they drove four or fewer months, and 54% estimated they drove less than 50 miles per month. Thus, it does not appear that this is a sample of extraordinarily active bicyclists.

*Description of accidents.* Subjects were asked to supply accident details for their most serious accident within the past 12 months, or, if there were none that recent, the most serious within the past five years. While 390<sup>2</sup> (32%) of the subjects reported having at least one accident in this time frame, details are available for only approximately 366 accidents because of some respondents who gave few or no details for their reported accidents. The percentages reported in this section will use as a base the number of subjects who responded to each question.

Variables 67-102 give a general description of the accidents of these young adults. As one would expect, the majority of accidents occurred in June (18%), July (23%), and August (11%). The six months from May to October included 78% of all reported accidents. Weekends, which account for 29% of the week, were not as over-represented as one might ex-

<sup>2</sup> An additional 220 subjects in the 16 to 20 year-old-age group reported details of an accident that occurred more than one year ago. Since these accidents could have happened when the subjects were less than 16, they have been excluded from this report. Analysis of the excluded accidents supported the assumption that they may have been children's accidents by showing, for example, an increased ratio of falls to collisions, which is more characteristic of children's bicycle accidents than of adult's.

pect, with 32% of the accidents (Variable 69). Surprisingly, over twice as many accidents were reported on Saturday as on Sunday. Sixty-four percent of the accidents were reported as happening between noon and 6 p.m. (Variable 70). Most accidents occurred in the first 20 to 25 minutes of the drive (54%) and within one mile of home (74%) (Variables 81 and 82).

Examination of the bicycling environment did not disclose any startling conditions. Driving tended to be in good weather (74%) and was most often on secondary (46%) or main streets (23%) with light or no traffic (69%). Only 14% of the driving was against traffic or in the middle of the street, the remainder being either "with" traffic or not on a street (Variable 79). The accident area was residential in 56% of the cases (Variable 83) and was a place where the bicyclists had driven often before, 69% of the time (Variable 86). Intersections of some kind were the place of occurrence in 43% of the accidents (Variable 90) with almost half of these being the intersection of two streets.

Type of accident (Variable 89) may be categorized as falls and collisions. Using this dichotomy, 33% of the accidents were classified as falls and 67% as collisions. Crashes involving motor vehicles made up 32% of the collisions (21% of all accidents). Considering the activity just before the accident (Variable 84), the largest single category was driving straight ahead (49%), with turns making up another 22%, and getting on, starting, and getting off accounting for 12%. Of all the respondents, 77% were sitting on the bicycle seat (Variable 87) and 48% were attempting some evasive maneuver (Variable 88) as the accident happened.

Some personal injury was the result of 79% of these reported accidents (Variable 95). Minor scrapes, cuts, and bruises were the most common results, accounting for 79% of the injuries. Injury treatment (Variable 99) was provided by a doctor or hospital in 12% of the cases, while 73% of the injuries were either self-treated or not treated at all. Arms and legs were the parts of the body most often injured, each accounting for 38% of the reported injuries. Injury resulted from direct contact with the ground in 66% of the reported accidents and from contact with bicycle parts in 15% (Variable 98). Some bicycle part failed in 18% of the accidents (Variable 91), though it is impossible to determine

from these data whether the failures caused or resulted from the accidents. The police or insurance companies were notified in only 7% of these accidents.

### ***Multivariate Comparisons***

While the preceding section gives a general overview of the data, other questions require comparisons among two or more variables. One of the problems of survey research is that the number of possible comparisons among variables is often very large. In this study, only a few of the possible multivariate comparisons were examined. These were chosen either because past research (often on children) had shown these variables to be important, or because of general interest in the bicycling community.

*Accidents, mileage, and accident rates.* Variable 65 gives the number of bicycle accidents involving any damage or injury in the past 12 months. There were 248 subjects (21%) who reported having had at least one accident in the past year. These subjects reported 373 accidents for an average of 1.5 accidents. The whole group of 1,197 subjects who responded to the question therefore experienced a rate of .31 accidents per person, per year.

In Table 1, Section A, accident rates per person were broken down by sex and type of bicycle. The male rate of .32 accidents was slightly higher than the female rate of .30. Among bicycle types (which for the multivariate comparisons were divided into three categories based on their number of gears), the higher speed bicycles (5-, 10-, 15-gears) had a much higher per-person rate (.42 accidents) than the 3-speed (.26) or 1-speed (.21) bicycles. When sex and bicycle type were examined simultaneously, however, the picture changed. Here females had higher rates for both 3-speed and 5-, 10-, 15-speed bicycles (.35 and .41 respectively) while the male rate increased only for the 5-, 10-, 15-speed bicycles.

Variables 8 (number of months of regular driving) and 9 (miles driven per month) were used to estimate annual mileage. These estimates, shown in Table 1, Section B, were broken down by sex and type of bicycle. While the estimates are useful in making comparisons between groups in this study, one must be very cautious in generalizing from these mileage figures. Estimated average annual mileage for the entire group was 607 miles per person. Male mileage was 55% higher than female mileage (705 miles and 456 miles, respectively). Mileage also increased steadily

Table 1.—Accident and Mileage Rates by Rider Sex and Type of Bicycle

	Sex	Type of Bicycle			Total
		1-gear	3-gear	5-, 10-, 15-gears	
A	Male	.21	.20	.43	.32
	Female	.20	.35	.41	.30
	Total	.21	.26	.42	.31
B	Male	275	481	980	705
	Female	298	504	612	456
	Total	287	491	882	607
C	Male	.76	.42	.44	.45
	Female	.68	.69	.67	.67
	Total	.72	.54	.48	.51
D	Male	153	171	406	730
	Female	180	140	140	460
	Total	333	311	546	1,190

<sup>a</sup>These numbers are approximate because each of the variables involved (1, 8, 9, 24, have slightly varying numbers of nonrespondents.

with number of gears, 5-, 10-, 15-speed bicycle mileage of 882 miles being 80% higher than the 3-speed bicycle mileage of 491 miles which, in turn, was 70% higher than the 1-speed bicycle mileage of 287 miles per person, per year. The pattern was similar to that shown for accidents when examining both sex and type of bicycle. Female mileage was equally high for both 3-speed and 5-, 10-, 15-speed bicycles, while male mileage increased steadily with bicycle gearing.

Mileage and accident information were combined to calculate accident rates per 1,000 miles of bicycle driving for sex and type of bicycle groups in Table 1, Section C. Again, although these rates are most useful in making comparisons between groups in this study, their absolute values may or may not be reasonable estimates of the "true" rate for young adults across the nation. The data collection method used in this

study did not control potential sources of bias in a way that allowed precise generalizations to a larger universe. For the same reasons, tests of statistical significance were not appropriate for this study. Rather the direction of large differences was examined and the possible importance of these differences discussed.

The overall accident rate was .51 accidents per 1,000 miles. The pattern for males and females for the three bicycle types was very different as seen in Figure 1. Males, whose overall rate of .76 accidents per 1,000 miles, had a much higher rate on 1-speed bicycles (.76 per 1,000 miles) on 1-speed bicycles. Females, whose overall accident rate of .67 per 1,000 miles, had an accident rate almost 50% higher than the male rate, had approximately equal accident rates for all three bicycle types. The combined accident rates for the three

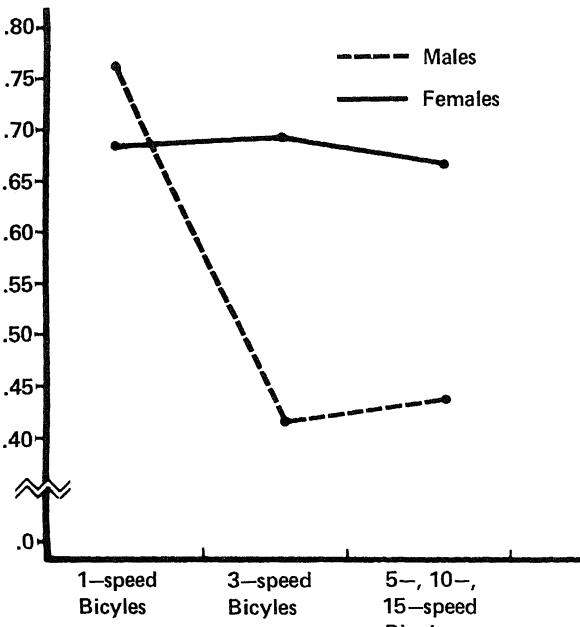


FIG. 1.—Accidents per 1,000 miles for males and females by type of bicycle.

types showed a steady decrease with increasing number of gears, the 1-speed accident rate of .72 per 1,000 miles being 50% higher than the 5-, 10-, 15-speed rate of .48 accidents per 1,000 miles.

The important difference between accidents per person and the accident rate per 1,000 miles is shown dramatically in Figure 2. Here one can see that if only calculations for accident per person were available it would be assumed that the more gears a bicycle has, the more dangerous it is. When exposure (mileage) is controlled for, however, by calculating a rate per 1,000 miles, the trend is exactly the opposite. In other words, in these data, 5-, 10-, 15-speed bicycles had more accidents only because they were driven so many more miles.

*Sex and type of bicycle comparisons.* Two important explanatory variables explored in this study were sex of rider and type of bicycle. Differences between males and females have been examined in research both on children's bicycle accidents and adult

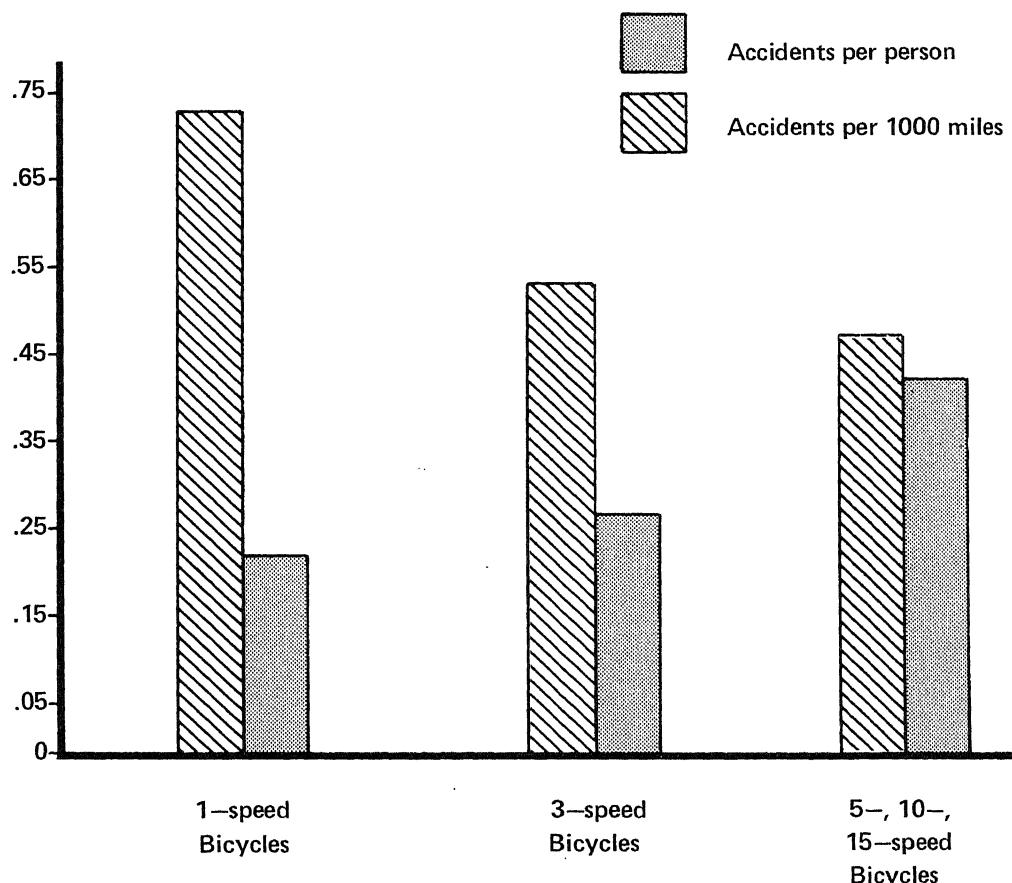


FIG. 2.—Accident and mileage rates by type of bicycle.

**Table 2.—Recoded Variables Showing Original and Recoded Categories**

Number	Variable Name	Old Categories	New Categories
46	Day of week of most recent bicycle use	1. Monday 2. Tuesday 3. Wednesday 4. Thursday 5. Friday 6. Saturday 7. Sunday 8. Some weekday 9. Some weekend	1,2,3,4, 5,8 6,7,9 Weekday Weekend
50	Primary purpose of drive on most recent bike use day	1. Commuting to or from work 2. Bike hike or touring 3. Traveling to/from recreation site 4. Racing or sporting event 5. Exercise or health 6. Just for fun 7. Traveling on an errand	1,2,3,7 4,5,6 Transportation Recreation
72	Purpose of drive just prior to accident	1. Commuting to or from work 2. Bike hike or touring 3. Traveling to/from recreation site 4. Racing or sporting event 5. Exercise or health 6. Just for fun 7. Traveling on an errand	1,2,3,7 4,5,6 Transportation Recreation
84	Type of accident	1. Motor vehicle struck bike 2. Bike struck moving motor vehicle 3. Bike struck parked motor vehicle 4. Bike crashed avoiding motor vehicle 5. Bike collided with other bike 6. Bike hit or fell off curb 7. Bike hit hole, bump, or obstacle 8. Rider skidded and crashed 9. Rider lost balance and fell	1,2,3,4 5,6,7 8,9 Motor vehicle related collision Other collision Fall
95	Result of accident	1. Personal injury 2. Bicycle damage 3. Property damage 4. 1 and 2 5. 1 and 3 6. 2 and 3 7. 1, 2, and 3	1,4,5,7 2,3,6 Injury accident No injury

automobile driving. Safety differences between various bicycle types are of interest to both bicyclists and bicycle manufacturers. In the present data, there was a significant relationship between sex of rider and bicycle type (Table 1, Section D,  $\chi^2=77.6$ ,  $df=2$ ,  $p<.001$ ) with males having proportionately more bicycles with five or more speeds (56%) than females (30%). Because of this relationship, associations of rider sex and type of bicycle with selected usage and

accident variables were more fully explored. Several of these variables were recorded for use in these analyses, as is shown in Table 2.

There were several important and internally consistent differences in the usage pattern of the three bicycle types. Table 3 indicates that higher speed bicycles were used in heavier motor-vehicle traffic (Variable 58), more frequently than lower speed types. While 53% of the 5-, 10-, 15-speed bike usage

**Table 3.—Type of Bicycle by Motor Vehicle Traffic Density at Most Recent Bicycle Use**

Type of Bicycle	Motor Vehicle Traffic								Total	
	High		Moderate		Low		None			
	f	%	f	%	f	%	f	%	f	%
1-speed	19	5.8	107	32.4	159	48.2	45	13.6	330	100.0
3-speed	21	6.8	130	42.1	128	41.4	30	9.7	309	100.0
5-,10-,15-speed	58	10.7	227	42.0	211	39.1	44	8.1	540	100.0
Total	98	8.3	446	39.4	498	42.2	119	10.1	1179	100.0

$\chi^2 = 23.13$ ,  $df = 6$ ,  $p < .001$

**Table 4.—Type of Bicycle by Primary Purpose of Most Recent Bicycle Use for Males**

Type of Bicycle	Primary Purpose of Drive				Total	
	Transportation		Recreation			
	f	%	f	%	f	%
1-speed	50	32.9	102	67.1	152	100.0
3-speed	82	48.5	87	51.5	169	100.0
5-,10-,15-speed	217	54.7	180	45.3	397	100.0
Total	349	48.6	369	51.4	718	100.0

$\chi^2 = 20.84$ ,  $df = 2$ ,  $p < .001$

was reported as being in heavy or moderate traffic, 49% of the 3-speed bicycle usage and only 38% of the 1-speed bicycle usage was so reported (Table 3). Other statistically significant, though less dramatic, differences among bicycle types were found with Variable 56 (1-speed bicycles used proportionately less than other types on pavement), Variable 59 (5-, 10-, 15-speed bicycles used proportionately more in business areas and less in residential areas), Variable

60 (5-, 10-, 15-speed bicycles driven proportionately more on main streets and less on secondary streets), and Variable 61 (1-speed bicycles driven proportionately more off the street, whereas 5-, 10-, 15-speed bicycles were driven more with traffic). The 3-speed bicycles fall between the higher and lower speed types in all of these analyses.

Variable 50, primary purpose of drive, may provide the best summary of these differences. When sep-

**Table 5.—Type of Bicycle by Primary Purpose of Most Recent Bicycle Use for Females**

Type of Bicycle	Primary Purpose of Drive				Total	
	Transportation		Recreation		f	%
	f	%	f	%		
1-speed	78	43.8	100	56.2	178	100.0
3-speed	67	49.3	69	50.7	136	100.0
5-,10-,15-speed	72	52.6	65	47.4	137	100.0
Total	217	48.1	234	51.9	451	100.0

$\chi^2 = 2.47$ , df = 2, NS

**Table 6.—Purpose of Drive at Time of Accident by Type of Bicycle for Males**

Type of Bicycle	Primary Purpose of Drive				Total	
	Transportation		Recreation		f	%
	f	%	f	%		
1-speed	12	26.7	33	73.3	45	100.0
3-speed	22	53.7	19	45.3	41	100.0
5-,10-,15-speed	87	56.5	67	43.5	154	100.0
Total	121	50.4	119	49.6	240	100.0

$\chi^2 = 12.60$ , df = 2,  $p < .01$

arated into driving for transportation or recreation, the higher-speed bicycles tended to be used more for transportation (54%), and lower speeds for recreation (61%), with the two use categories split almost evenly for 3-speed bikes ( $\chi^2=19.47$ ,  $df=2$ ,  $p<.001$ ).

Usage of different types of bicycles varied when sex of driver was considered, however. The aforementioned relationship between usage and bicycle type held for males as shown in Table 4 but, as Table 5 indicates, was not significant for females.

It should be emphasized that there were no overall differences in bicycle use between males and females in this sample when type of bike was not considered.

Looking at purpose of drive on the last driving day (Tables 4 and 5) for example, we see that 49% of the males and 48% of the females used their bicycles for transportation. The significant association between type of bike and usage that was present for males and not for females provides a possible explanation for the finding that male accident-mileage rates differed among bicycle types, while female rates did not, i.e., the males tended to use the different types of bikes for different purposes and females did not.

Examination of accident details also failed to provide a clear explanation for females having higher accident rates than males. Of 25 accident detail

Table 7.—Type of Accident by Sex

Sex	Type of Accident						Total		
	Motor-vehicle Related		Other Collisions		Falls				
	f	%	f	%	f	%	f	%	
Male	65	27.4	92	38.8	80	33.8	237	100.0	
Female	11	9.1	71	58.7	39	32.2	121	100.0	
Total	76	21.2	163	45.5	119	33.2	358	100.0	

$\chi^2 = 19.68$ ,  $df = 2$ ,  $p < .001$

Table 8.—Result of Accident by Sex for 1-Speed Bicycles

Sex	Result of Accident				Total		
	Injury		No Injury				
	f	%	f	%	f	%	
Male	33	73.3	12	26.7	45	100.0	
Female	37	100.0	0	0	37	100.0	
Total	70	85.4	12	14.6	82	100.0	

$\chi^2 = 9.52$ ,  $df = 1$ ,  $p < .01$

variables examined, only one (Variable 72) was related to type of bicycle, four (Variables 79, 89, 95, 97) were related to sex, and one (Variable 85) was related to both type of bicycle and sex. Variable 72, purpose of drive at time of accident, reflected the exposure difference shown in Tables 4 and 5. Table 6 shows Variable 72 by type of bike for males, and the pattern was very similar to the exposure pattern for males, i.e., with 1-speed bicycles being used mostly for recreation and 5-, 10-, 15-speed bicycles being used more for transportation. For females there was

no significant relationship between purpose of drive at time of accident and type of bike. The other related accident variable with an exposure counterpart was Variable 79, orientation of bicycle in traffic. There was no exposure difference between males and females, but at time of accident males were driving proportionately more on the street with traffic and females proportionately more in off-street locations ( $\chi^2=10.45$ ,  $df=3$ ,  $p<.02$ ).

Table 7 shows the significant relationship between type of accident (Variable 89) and sex. This rela-

Table 9.—Part of Body Injured by Sex of Rider

Sex	Part of Body Injured						Total	
	Arms		Legs		All Other			
	f	%	f	%	f	%	f	%
Male	104	45.2	62	27.0	64	27.8	230	100.0
Female	31	25.2	74	60.2	18	14.6	123	100.0
Total	135	38.2	136	38.5	82	23.2	353	100.0

$\chi^2 = 37.33$ ,  $df = 2$ ,  $p < .001$

Table 10.—Speed at Time of Accident by Type of Bicycle for Males

Type of Bicycle	Speed at Accident						Total	
	Less than 5 mph <sup>a</sup>		5 - 15 mph		More than 15 mph			
	f	%	f	%	f	%	f	%
1-speed	13	28.2	24	52.2	9	19.6	46	100.0
3-speed	7	17.0	30	73.2	4	9.8	41	100.0
5-, 10-, 15-speed	23	14.9	87	56.5	44	28.6	154	100.0
Total	43	17.8	141	58.5	57	23.7	241	100.0

<sup>a</sup>includes "stopped"

$\chi^2 = 10.72$ ,  $df = 4$ ,  $p < .05$

tionship remained unchanged even when examined separately for the three types of bicycles. Males had proportionately more motor-vehicle related accidents and females more "other collisions," i.e., collision with objects other than motor vehicles. The proportion of falls was about equal for both. Sex was also significantly related to result of accident (Variable 95). When broken down by type of bicycle, however, the relationship was significant only for 1-speed bicycles.

Overall, 79% of the reported accidents resulted in some personal injury.<sup>3</sup> This held true for both males and females driving 3-speed or 5-, 10-, 15-speed bicycles and for males driving 1-speed bicycles. Accidents reported by females on 1-speed bicycles, however, resulted in personal injury 100% of the time (Table

<sup>3</sup> While 79% may appear high, this is partly a result of the "definition" of accident that appears in Variable 65.

Table 11.—Speed at Time of Accident by Type of Bicycle for Females

Type of Bicycle	Speed at Accident						Total	
	Less than 5mph <sup>a</sup>		5 - 15mph		More than 15mph			
	f	%	f	%	f	%	f	%
1-speed	13	35.1	23	62.2	1	2.7	37	100.0
3-speed	18	45.0	20	50.0	2	5.0	40	100.0
5-, 10-, 15-speed	20	41.7	21	43.7	7	14.6	48	100.0
Total	51	40.8	64	51.2	10	8.0	125	100.0

<sup>a</sup>includes "stopped"

$\chi^2 = 6.22$ , df = 4, NS

Table 12.—Accident Group by Type of Bicycle

Accident Group	Type of Bicycle						Total	
	1-speed		3-speed		5-, 10-, 15-speed			
	f	%	f	%	f	%	f	%
A	89	22.9	87	22.4	212	54.6	388	100.0
NA	244	30.3	225	28.0	335	41.7	804	100.0
Total	333	27.9	312	26.2	547	45.9	1192	100.0

$\chi^2 = 17.83$ , df = 2,  $p < .001$

8). The significant relationship between sex and part of body injured (Variable 97) was largely caused by males reporting proportionately more injuries to arms while females reported proportionately more injuries to legs (Table 9). Type of bicycle had no effect on this relationship.

Finally, the reported speed of the bicycle before the accident (Variable 85) was related to both sex and type of bicycle with males and higher speed bicycles tending to be traveling at higher speeds at the time of the accident. Males reported higher speeds than females at time of accident for each of the three bicycle types, though the association between speed and bicycle type as seen in Tables 10 and 11 was significant only for males. This finding is consistent with the other patterns in that only males reported differences in use of the three bicycle types.

*Accident group vs. no-accident group comparisons.* Knowledge of differences between accident (A) and no-accident (NA) groups of bicyclists in exposure and usage patterns could help point out driving habits that are especially likely to result in accident occurrence. For these analyses, the A Group (N=390) was composed of those subjects who reported details of an accident they had as adults within the past five years, and the NA Group (N=832) was made up of all other subjects. Comparisons between these groups were made with sex, type of bicycle, exposure (Variables 7, 8, 9, and 11) and all 19 of the variables concerning most recent bicycle use (Variables 46-64). These comparisons can be seen clearly in Appendix D,

since the frequency distributions were reported separately for the A and NA Groups.

There was no significant relationship between sex and accident group membership. Thirty-three percent of the males and 29% of the females were in the A Group ( $\chi^2=2.27$ , df=1, NS). This was in agreement with the similarity between male and female accident rates per person (Table 1). A significant relationship was evident between type of bicycle and accident group membership (Table 12). Highest speed bicycles made up 55% of the A Group but only 42% of the NA Group, a difference of 13%. Both 10-speed and 3-speed bicycles were overrepresented in the A Group.

Of the four exposure variables examined, only driving more than 100 miles per year showed a significant relationship with accident group membership. As can be seen in Table 13, 40% of the A Group but only 25% of the NA Group drove more than 100 miles in more than one year from 1970 through 1972 (Variable 7). The A Group bicyclists also drove more months per year (Variable 8,  $\chi^2=20.41$ , df=5,  $p<.01$ ) and more miles per month (Variable 9,  $\chi^2=25.89$ , df=7,  $p<.001$ ). Surprisingly, there was no significant association between accident group membership and amount of time spent driving per month (Variable 11,  $\chi^2=10.74$ , df=7, NS). While the direction of the difference was fairly consistent, with NA Group bicyclists driving fewer miles per month, the lack of a significant relationship, coupled with the A Group's greater mileage, may be an indication of a

Table 13.—Accident Group by Years Driving More than 100 Bicycle Miles from 1970 through 1972

Accident Group	Years Driving More than 100 Bicycle Miles						Total	
	None		1 Year		More than 1 Year			
	f	%	f	%	f	%	f	%
A	136	35.0	97	24.9	156	40.1	389	100.0
NA	441	52.9	182	21.8	211	25.3	834	100.0
Total	577	47.2	279	22.8	367	30.0	1223	100.0

$$\chi^2 = 38.55, \text{ df} = 2, p < .001$$

the A Group has a higher average speed. These data, however, were not sufficiently accurate to test this hypothesis.

Of the 19 "most recent bicycle use" variables, only five were significantly related to accident group membership. A Group bicyclists' last drive was more recent than the NA Group's (Variable 47,  $\chi^2=30.87$ ,  $df=6$ ,  $p<.001$ ). "Yesterday" and two-four days ago accounted for 48% of the A Group's most recent drives but only 35% of the NA Group's. The A Group bicyclists were somewhat more likely to be using their own bicycle on their last drive (86%) than the NA Group (78%) (Variable 49,  $\chi^2=9.17$ ,  $df=1$ ,  $p<.01$ ). There was also a significant difference in primary purpose of last drive (Variable 50), which can be seen in Table 14. More than half (54%) of the A

Group driving was for transportation while the comparable figure for the NA Group was 45%. The relationships are reversed for recreational use. This was consistent with the significant difference found in Variable 58, shown in Table 15. The A Group bicyclists were in "heavy" or "moderate" traffic on 55% of their last drives while the percentage for the NA Group was only 43%. The final significant relationship was with weather (Variable 55). Some adverse weather conditions were reported by 43% of the A Group and 33% of the NA Group.

Another potentially interesting analysis would have been the comparison of the NA Group exposure details with A Group accident details. This comparison could aid in discovering bicycling activities that are unusually hazardous independent of exposure. The

**Table 14.—Accident Group by Primary Purpose of Most Recent Drive**

Accident Group	Primary Purpose of Most Recent Drive				Total	
	Transportation		Recreation			
	f	%	f	%	f	%
A	208	53.9	178	46.1	386	100.0
NA	368	44.8	454	55.2	822	100.0
Total	576	47.7	632	52.3	1208	100.0

$\chi^2 = 8.75$ ,  $df = 1$ ,  $p < .01$

**Table 15.—Accident Group by Motor Vehicle Traffic at Most Recent Drive**

Accident Group	Motor Vehicle Traffic Density								Total	
	High		Moderate		Low		None			
	f	%	f	%	f	%	f	%	f	%
A	44	11.3	171	43.8	150	38.5	25	6.4	390	100.0
NA	54	6.5	301	36.4	365	44.1	108	13.0	828	100.0
Total	98	8.0	472	38.8	515	42.3	133	10.9	1218	100.0

$\chi^2 = 23.97$ ,  $df = 3$ ,  $p < .001$

NA Group exposure details, however, are biased toward the month of October and toward driving on college campuses. The accident reports are not biased in this way, representing events that occurred during the last 12 months, and so any comparisons between the two would be uncertain and, in some cases, fallacious. The number of accidents that occurred in October in this sample was not a sufficiently large subgroup to be used in such an analysis.

#### *Comparison of Young Adult vs. Children's Bicycle Driving Experience*

A recent National Safety Council report (Reference 1) analyzed many of the same variables as this report, but for a nationally representative sample of elementary school-aged children. The following discussion of the similarities and differences between the bicycle driving of children and young adults may help in the design of future studies and be useful in developing bicycle safety programs for young adults. Comparisons were made in three areas: bicycle characteristics, exposure, and accident details.

Nearly three-quarters of both the children's and young adults' bicycles were bought new. More of the children's bicycles, however, had to be assembled (33%)<sup>4</sup> than the young adults' bicycles (19%). Light weight and racer bicycles made up only 9% of the children's bicycles while 70% of the young adults' bicycles had three or more gears. Consistent with this difference, 69% of young adult bicycles were reported to have hand brakes, while 69% of the children's bicycles had coaster brakes. The adult bicycles were also more likely to have front lights (37%) and rear reflectors (80%) than the children's bicycles (15% and 70%, respectively).

Details of the most recent driving day were collected in May in the children's study and in October for the adults in this study. The difference should be kept in mind in interpreting the findings in this paragraph. Children used their bicycles more recently than adults, 62% reporting their last drive to be yesterday or two days ago compared to only 29% of the adults. As would be expected, there was a large difference in purpose of drive. The adult experience was approximately evenly divided between transportation and recreation, while the latter made up 72% of the children's driving. Adults also drove in the

street much more often than children and in heavier motor vehicle traffic. Adults were more likely to be on their bicycles in adverse weather, but less likely to carry a passenger. Both children and adults did most of their bicycle driving on pavement, but this was especially true of adults (91% to 72% of last drives). Almost twice as many children as adults reported that they fell on their last outing (11% and 6%, respectively).

The adults in this study reported about .31 accidents per person per year compared to about .48 accidents for children. The accident rates per 1,000 miles showed a similar pattern, being estimated at about .51 accidents for young adults and .72 accidents for children. The day of accident was the same for children and adults with roughly one-third of accidents happening on weekends. Time of accidents was also similar, with noon to 6 p.m. accounting for over half of all accidents. Consistent with the exposure difference, the bicycle was being used for transportation more when adult accidents occurred than children's.

Adult accidents were in areas with motor vehicle traffic 63% of the time compared to 48% for children. Consistent with this, collisions involving motor vehicles accounted for 19% of the adult accidents but only 10% of the children's. Another interesting type of accident comparison shows that 25% of children's accidents involved losing balance compared to only 12% for adults. Falls and collisions were about equally divided for children, but two-thirds of the adult accidents were collisions. Activity before the accident was similar for children and adults, simply driving ahead accounting for 46% of the accidents of both groups. Type of injury was about the same for children and adults with scrapes, cuts, and bruises making up 65% and 69% of the injuries, respectively. Children, however, were more likely to receive professional medical attention (22% to 11%). In summary, then, the difference in adult vs. child accidents generally mirror the differences in adult vs. child exposure.

#### **Summary and Conclusions**

This study represented a first attempt to collect some basic usage and accident data on adult bicycle drivers. It was decided to limit our concern to young adults, aged 16 to 30. Subjects were drawn from 27 college campuses representing all nine U.S. Census areas. While not an adequately representative sample of young adults, the data should be useful as bench-

<sup>4</sup> Since the percentages in the children's bicycle study were calculated with nonrespondents included, nonrespondents were also included for the adult study in this section only.

marks for certain parameters of adult bicycle usage and accidents, as a pilot test of the methodology employed, and as a stimulus to further research in the area of adult bicycling.

Simple frequency distributions of all variables were compiled (Appendix D) and make up the basic data of the study. Selected variables were discussed in the text to provide an overview of young adult bicycling experience. In addition to this elementary analysis, three other types of analysis were performed. First, rider sex and type of bicycle were selected for more intense probing. These variables were picked because of their importance in previous bicycle safety research and their interest to the bicycling community. Second, the data for accident and no-accident group bicycle driving experience were compared. Last, the bicycling of these young adults was compared to that of a sample of elementary school children measured in an earlier National Safety Council study.

The overview of young adult bicycling was highlighted by the following facts. The most common bicycle features were 10-speeds (38%), hand brakes (64%), regular handlebars (59%), and no front light (62%) but a rear reflector (82%). Over half of the subjects reported that their most recent drive was one week ago or sooner. This last driving day was generally done alone (69%), on dry pavement (91%), with moderate to light motor vehicle traffic (81%), and in a residential area (64%). The most common purposes for bicycling were "just for fun" (39%), exercise or health (13%), and commuting (27%). Six percent reported they fell on their most recent driving day. As one would expect, the majority of accidents (52%) occurred in June, July, or August. The hours from noon to 6 p.m. accounted for 64% of the accidents. When categorizing accident type into collisions or falls, collisions make up 67% of the accidents and falls 33%. Some personal injury was the result of 79% of these accidents.

One of the important results of the more intensive analysis by sex and type of bicycle was the discovery of strong interactions between these two variables. For example, estimated annual mileage without regard for bike type for males was greater than that for females (705 to 456 miles), but females had greater estimated mileage for 1-speed and 3-speed bicycles than males. Accident rates per 1,000 miles were

higher for females (.67) than for males (.45). These rates were also highest for 1-speed bicycles (.72 accidents per 1,000 miles) and lowest for 5-, 10-, 15-speed bicycles (.48). If only the number of accidents per person are examined, however, the higher speed bicycles have the highest rates.

Males in this sample were much more likely to drive higher-speed bicycles than females. Males seem to use the three types of bicycles (1-speed, 3-speed, 5-, 10-, 15-speed) in different ways, while females use all of them similarly. This sex difference in usage may explain why male accident-mileage rates differed among bicycle types while female rates did not.

There were some differences distinguishing accident (A) group from no-accident (NA) group bicycle drivers. Most importantly, the A Group did more bicycling, reporting both more months driving per year and more miles per month. The accident group did not, however, spend significantly more time driving per month, leading to the supposition that this group had a higher average speed. This hypothesis was not tested. Of the 19 "most recent bicycle use" variables, only five were significantly related to accident group membership. The A Group's last outings were more recent, more often on their own bicycles, more for transportation, more in "heavy" or "moderate" motor vehicle traffic, and more often in some adverse weather.

The final analysis compared a nationally representative sample of elementary school-aged children to this sample of young adults. There were differences in several areas. Adults had more higher-geared (3-, 5-, 10-, 15-speed bicycles) while the children were driving mainly high-rise and middle-weight bicycles, all of which were essentially 1-geared or "1-speed" vehicles. While adult bicycle driving was evenly divided between transportation and recreation, approximately three-quarters of the children's driving was for recreation. Adults drove more in the street and in heavier motor vehicle traffic. These patterns were also reflected in the accident details. In addition, it was found that collisions made up 67% of adult accidents but only about half of the children's accidents. More specifically, loss of balance accounted for 25% of the children's accidents but only 12% of the adults'. In general, the difference in accident patterns between the young adults and children reflected differences in their respective exposure patterns.

## REFERENCES

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<sup>2</sup> Flora, J., Kaplan, R., Margoshes, E., & Ward, P. *The national electronic injury surveillance system and bicycle associated accidents*. Ann Arbor: University of Michigan, Highway Safety Research Institute, October 1975. (Report No. UM-HSRI-SA-75-18)

<sup>3</sup> Kaplan, J. A. *Characteristics of the regular adult bicyclist user*. Federal Highway Administration, July 1975. (NTIS No. PB-258 399, \$6.00)

<sup>4</sup> Vilardo, F. J., & Andersen, J. H. *Bicycle accidents to school-aged children*. Chicago: National Safety Council, 1969 (NTIS No. PB-187 675, \$3.00)

<sup>5</sup> Vilardo, F., Nicol, M., & Heldreth, H. *An investigation into bicycle usage*. Chicago: National Safety Council, 1968 (NTIS No. PB-187 674, \$3.00)

## APPENDIX A

### TOWARD BETTER BICYCLING NATIONAL SAFETY COUNCIL - CITY OF CHICAGO

READ EACH QUESTION AND WRITE IN THE BOX THE NUMBER OF THE ANSWER THAT BEST DESCRIBES YOU OR YOUR BICYCLE RIDING.

YOU		MILES									
		PER DAY OR	PER WEEK OR	PER MONTH							
SEX		9. NUMBER OF MILES YOU RODE DURING THOSE MONTHS THIS YEAR. (CIRCLE ANSWER AND PUT ROW NUMBER IN BOX)									
1) MALE	2) FEMALE										
AGE (YEARS)		5) 31 - 35									
1) 15 OR LESS	2) 16 - 20	3) 21 - 25	4) 26 - 30	5) 36 - 45	6) 46 - 55						
6) 56 - 65	7) 66 - 75	8) 76 - 85	9) OVER 85								
HEIGHT (FEET, INCHES)		4) 5'7" - 5'9"									
1) 5' OR LESS	2) 5'1" - 5'3"	3) 5'4" - 5'6"	4) 5'10" - 6'0"	5) 6'1" - 6'3"	6) 6'4" OR OVER	7) 6'7" - 6'9"					
WEIGHT (POUNDS)		5) 155 - 169									
1) 109 OR LESS	2) 110 - 124	3) 125 - 139	4) 140 - 154	5) 170 - 184	6) 185 - 199						
7) 200 - 214	8) 220 - 234	9) 215 OR OVER									
EDUCATION		10. NUMBER OF MILES YOU RODE DURING THOSE MONTHS LAST YEAR. (PICK A NUMBER FROM QUESTION #9)									
1) LESS THAN HIGH SCHOOL DIPLOMA	2) HIGH SCHOOL DIPLOMA	3) SOME COLLEGE	4) COLLEGE GRADUATE	5) POST GRADUATE WORK							
NUMBER OF MILES YOU HAVE DRIVEN A CAR IN THE PAST 12 MONTHS		11. AMOUNT OF ACTUAL RIDING TIME DURING THOSE TYPICAL RIDING MONTHS THIS YEAR.									
1) NONE	2) LESS THAN 1,000	3) 1 - 5,000	4) 6 - 10,000	5) 11 - 15,000	6) 16 - 20,000	7) 21 - 25,000					
8) 26 - 30,000	9) 31,000 OR MORE										
YEARS YOU HAVE RIDDEN A BIKE MORE THAN 100 MILES		12. AMOUNT OF BICYCLING									
1) 1972	2) 1971	3) 1970	4) '72 AND '71	5) '72 AND '70	6) '71 AND '70	7) '72, '71 AND '70					
8) NONE OF THESE				4) MUCH	5) VERY MUCH	6) ALMOST ALL					
NUMBER OF MONTHS YOU RIDE A BICYCLE REGULARLY DURING THE YEAR.		YOU DO ON EACH OF THE FOLLOWING:									
1) 1 - 2 MOS.	2) 3 - 4 MOS.	3) 5 - 6 MOS.	4) 7 - 8 MOS.	5) 9 - 10 MOS.	6) 11 - 12 MOS.	13. SECONDARY STREETS	14. BIKE PATHS, LANES	15. "BIKE ROUTE" STREETS	16. MAIN STREETS	17. SIDEWALKS	18. RURAL HIWAYS

## APPENDIX A—Continued

<u>YOUR BICYCLE</u>			
19. DO YOU PERSONALLY OWN AND RIDE MORE THAN ONE BIKE?		30. OTHER REFLECTIVE PAINT OR MATERIAL	
1) YES                    2) NO		1) NONE                    3) ON PEDALS 2) ON FRAME                4) MANY PLACES	
ANSWER THE FOLLOWING QUESTIONS ABOUT THE ONE BICYCLE YOU RIDE MOST.			
20. LENGTH OF TIME OWNED		31. EXTRA PASSENGER SEAT            1) NO 2) YES, DESCRIBE _____	
1) LESS THAN 1 MO.    5) 3 - 4 YEARS 2) 1 - 6 MONTHS        6) 5 - 10 YEARS 3) 7 - 12 MONTHS       7) MORE THAN 10 YRS. 4) 1 - 2 YEARS           8) DON'T OWN MY OWN		32. USE ONE OF THE FOLLOWING CATEGORIES 1) BICYCLE SHOP            4) FRIEND, FAMILY 2) MECHANIC               5) NO ONE, NOT NE 3) MYSELF                   6) NO ONE, BUT NE	
21. STYLE		TO DESCRIBE WHO PERFORMED THE MAINTENANCE PROCEDURES LISTED BELOW (#33 - 42) ON YOUR BIKE IN THE PAST 12 MONTHS (WHO USUALLY DID IT, IF MORE THAN ONCE?)	
1) MEN'S                    2) WOMEN'S		33. REPAIR TIRE                    37. ADJUST BRAKE	
22. FRAME SIZE		34. ADJUST HUB                    38. ADJUST GEARS	
1) 17"                    4) 21"                    7) 24" 2) 19"                    5) 22"                    8) 26" 3) 20"                    6) 23"                    9) 28"		35. REPAIR CHAIN                    39. WELD FRAME	
23. WHEEL SIZE		36. ADJUST SEAT                    40. ADJUST HANDLE	
1) 22"                    2) 24"                    3) 26"                    4) 27"		41. TRUE WHEEL (TIGHTEN SPOKES)	
24. GEARS		42. STRAIGHTEN FRAME, FORK OR CRANK	
1) 1-SPEED                4) 10-SPEED 2) 3-SPEED                5) 15-SPEED		43. AT THE TIME OF PURCHASE, THE BIKE	
25. BRAKES		1) NEW AND ASSEMBLED 2) NEW BUT NEEDED ASSEMBLING 3) USED AND IN GOOD REPAIR 4) USED BUT NEEDED REPAIR	
1) COASTER BRAKES 2) HAND BRAKES            3) BOTH		44. BIKE IS REGISTERED WITH 1) CITY                    3) BOTH 2) INSURANCE CO.            4) NONE	
26. HANDLEBARS		45. DISPOSITION OF PREVIOUS BIKE 1) SOLD, TRADED            4) STORED AWAY 2) JUNKED                    5) STILL HAVE 3) STOLEN                    AND STILL USE	
1) REGULAR                2) DROP-STYLE			
27. TOE STRAPS			
1) YES                    2) NO			
28. FRONT LIGHT			
1) NONE                    2) GENERATOR TYPE 3) BATTERY TYPE			
29. REAR REFLECTOR (OR LIGHT)			
1) YES                    2) NO			

## APPENDIX A—Continued

### MOST RECENT BIKE USE

THINK BACK TO THE LAST DAY BEFORE TODAY THAT YOU RODE ANY BIKE  
AND ANSWER THE FOLLOWING QUESTIONS AS CAREFULLY AS YOU CAN.

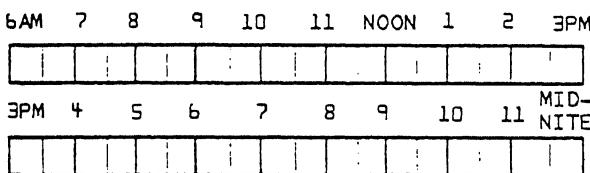
46. THAT DAY WAS

1) MONDAY	5) FRIDAY
2) TUESDAY	6) SATURDAY
3) WEDNESDAY	7) SUNDAY
4) THURSDAY	8) SOME WEEK DAY
	9) SOME WEEKEND

47. IT WAS

1) YESTERDAY	5) 1 WEEK AGO
2) 2 DAYS AGO	6) 1 MONTH AGO
3) 3 DAYS AGO	7) MORE THAN ONE
4) 4 DAYS AGO	MONTH AGO

48. DARKEN THOSE AREAS THAT REPRESENT  
ACTUAL RIDING TIME THAT DAY



49. RIDING

1) OWN BIKE JUST DESCRIBED	_____
2) ANOTHER BIKE	_____
(EXPLAIN)	

50. PRIMARY PURPOSE OF RIDE

1) COMMUTING TO OR FROM WORK
2) BIKE HIKE OR TOURING
3) TRAVELING TO OR FROM RECREATION SITE
4) RACING OR OTHER SPORT EVENT
5) GOOD EXERCISE FOR HEALTH
6) JUST FOR FUN
7) TRAVELING ON AN ERRAND

51. SECONDARY PURPOSE OF RIDE — ANOTHER  
FROM #50, OR ...

8) NONE

52. MOST OF THE RIDING WAS DONE

1) ALONE
2) WITH OTHER CYCLISTS

53. A PASSENGER CARRIED ON THE BIKE AT  
SOME TIME

1) YES 2) NO

54. SOMETHING CARRIED IN HAND AT ANY TIME  
WHILE RIDING

1) YES 2) NO

55. WEATHER

1) WINDY	3) CLOUDY
2) RAINING OR	4) FOGGY
SNOWING	
5) NONE OF THESE	

56. RIDING SURFACE MOSTLY

1) PAVEMENT	3) GRAVEL
2) GRASS	4) DIRT OR MUD

57. GROUND:

1) WET	2) DRY
--------	--------

58. MOTOR VEHICLE TRAFFIC

1) HEAVY	3) LIGHT
2) MODERATE	4) NONE

59. RIDING AREA:

1) RESIDENTIAL	3) BUSINESS
2) INDUSTRIAL	4) RURAL
5) PARK	

60. MOST OF THE RIDING WAS ON

4) SIDEWALKS	
1) MAIN STREETS	5) RURAL HIWAYS
2) SECONDARY STREETS	6) BIKE PATHS,
3) "BIKE ROUTE" STREETS	LANES

61. RIDING WAS

1) ON STREET WITH TRAFFIC
2) ON STREET AGAINST TRAFFIC
3) IN THE MIDDLE OF THE STREET
4) NOT ON A STREET

62. FARTHEST DISTANCE CYCLED FROM STARTING  
POINT (HOME) THAT DAY

1) LESS THAN 1 BLOCK
2) 1 - 5 BLOCKS
3) ABOUT 1 MILE
4) 2 - 4 MILES
5) 5 MILES OR MORE

63. WHILE RIDING THAT DAY, I

1) FELL
2) DIDN'T FALL

64. THAT DAY WAS LIKE MOST DAYS WHEN I RIDE  
MY BIKE

1) YES
2) NO (EXPLAIN)

## APPENDIX A—Continued

<u>BICYCLE ACCIDENTS</u>					
NUMBER OF BIKE ACCIDENTS HAPPENING TO YOU INVOLVING ANY DAMAGE OR INJURY					
65. ...IN THE PAST 12 MONTHS					
1) ONE	3) THREE	5) FIVE OR MORE	73. CARRYING		
2) TWO	4) FOUR	6) NONE	1) PASSENGER	3) BOTH OF THESE	
66. ...IN THE PAST FIVE YEARS			2) SOMETHING IN HAND	4) NONE OF THESE	
1) ONE	4) EIGHT - TEN				
2) TWO - FOUR	5) MORE THAN TEN				
3) FIVE - SEVEN	6) NONE				
PLEASE ANSWER THE FOLLOWING QUESTIONS CONCERNING THE MOST SERIOUS ACCIDENT WITHIN THE PAST 12 MONTHS. (IF THERE WERE NONE THAT RECENT, ONLY THEN DESCRIBE THE MOST SERIOUS WITHIN THE PAST 5 YEARS)					
67. MONTH ACCIDENT OCCURRED					
1) JAN	5) MAY	9) SEP	74. RIDING		
2) FEB	6) JUN	10) OCT	1) ALONE	3) CLOUDY	
3) MAR	7) JUL	11) NOV	2) WITH OTHER CYCLISTS	4) FOGGY	
4) APR	8) AUG	12) DEC		5) NONE OF THESE	
68. YEAR OF ACCIDENT					
1) 1972	3) 1970	5) 1968	75. WEATHER		
2) 1971	4) 1969	6) 1967	1) WINDY	3) CLOUDY	
69. DAY OF ACCIDENT			2) RAINING OR SNOWING	4) FOGGY	
1) MONDAY	5) FRIDAY			5) NONE OF THESE	
2) TUESDAY	6) SATURDAY				
3) WEDNESDAY	7) SUNDAY				
4) THURSDAY	8) SOME WEEK DAY				
	9) SOME WEEKEND				
70. TIME OF ACCIDENT					
1) 6 - 8 AM	5) 2 - 4 PM		76. RIDING SURFACE		
2) 8 - 10 AM	6) 4 - 6 PM		1) PAVEMENT	3) GRAVEL	
3) 10 AM - NOON	7) 6 - 8 PM		2) GRASS	4) DIRT	
4) NOON - 2 PM	8) 8 - 10 PM				
71. RIDING:					
1) OWN BIKE JUST DESCRIBED			77. GROUND		
2) ANOTHER BIKE	(EXPLAIN)		1) WET	2) DRY	
72. PURPOSE OF RIDE					
1) COMMUTING TO OR FROM WORK			78. RIDING ON		
2) BIKE HIKE OR TOURING			1) MAIN STREETS	3) RURAL H...	
3) TRAVELING TO OR FROM RECREATION SITE			2) SECONDARY STREETS	4) BIKE PA...	
4) RACING OR OTHER SPORT EVENT			3) "BIKE ROUTE" STREETS		
5) GOOD EXERCISE FOR HEALTH					
6) JUST FOR FUN					
7) TRAVELING ON AN ERRAND					
73. CARRYING					
1) PASSENGER			79. RIDING		
2) SOMETHING IN HAND			1) ON STREET WITH TRAFFIC	4) SIDEWAL...	
			2) ON STREET AGAINST TRAFFIC	5) RURAL H...	
			3) IN THE MIDDLE OF THE STREET	6) BIKE PA...	
			4) NOT ON A STREET		
80. MOTOR VEHICLE TRAFFIC WAS					
1) HEAVY			81. TIME RIDING BEFORE ACCIDENT		
2) MODERATE			3) JUST STARTED	4) 1/2 HOUR	
			2) 1/4 HOUR	5) ONE HOUR	
				5) 2 HOURS OR MORE	
82. DISTANCE FROM HOME					
1) LESS THAN 1 BLOCK			3) 1 MILE		
2) 1 - 5 BLOCKS			4) 2 - 4 MILES		
			5) 5 MILES OR MORE		
83. ACCIDENT AREA					
1) RESIDENTIAL			3) BUSINESS		
2) INDUSTRIAL			4) RURAL		
			5) PARK		

## APPENDIX A—Continued

### ACCIDENT DETAILS CONT'D.

<p>84. ACTIVITY BEFORE ACCIDENT</p> <p>1) GETTING ON 5) TURNING LEFT 2) STARTING UP 6) STOPPING 3) RIDING AHEAD 7) TURNING RIGHT 4) GETTING OFF 8) TRICK OR STUNT</p> <p>85. SPEED BEFORE ACCIDENT</p> <p>1) 5 - 15 MPH 3) MORE THAN 15 MPH 2) STOPPED 4) LESS THAN 5 MPH</p> <p>86. TIMES RIDDEN THERE BEFORE</p> <p>1) OFTEN 2) A FEW TIMES 3) NEVER</p> <p>87. AS THE ACCIDENT HAPPENED WERE YOU</p> <p>1) STANDING ON THE PEDALS 2) SITTING ON THE SEAT 3) RIDING IN SOME OTHER MANNER</p> <p>88. AS ACCIDENT WAS EVIDENT, DID YOU</p> <p>1) BRAKE HARD 2) SWERVE LEFT 4) YELL A WARNING 3) SWERVE RIGHT 5) JUST CRASH</p> <p>89. TYPE OF ACCIDENT</p> <p>1) MOTOR VEHICLE STRUCK BIKE 2) BIKE STRUCK MOVING MOTOR VEHICLE 3) BIKE STRUCK PARKED MOTOR VEHICLE 4) BIKE CRASHED AVOIDING MOTOR VEHICLE 5) BIKE COLLIDED WITH OTHER BIKE 6) BIKE HIT OR FELL OFF CURB 7) BIKE HIT HOLE, BUMP, OR OBSTACLE 8) BIKE SKIDDED AND CRASHED 9) RIDER LOST BALANCE AND FELL</p> <p>90. ACCIDENT OCCURRED AT INTERSECTION OF</p> <p>1) A DRIVEWAY AND A SIDEWALK 2) A DRIVEWAY AND A STREET 3) AN ALLEY AND A STREET 4) AN ALLEY AND A SIDEWALK 5) TWO SIDEWALKS 6) TWO STREETS 7) NO INTERSECTION</p> <p>91. DID ANY PART OF THE BIKE FAIL?</p> <p>1) PEDALS 4) CHAIN 7) HANDLEBARS 2) BRAKES 5) GEARS 8) OTHER 3) WHEEL 6) SEAT 9) NONE</p> <p>92. WERE YOU STRUCK FROM THE</p> <p>1) RIGHT 3) FRONT 2) LEFT 4) REAR 5) NOT STRUCK</p>	<p>93. DID YOU FALL OVER THE</p> <p>1) HANDLE BARS 2) REAR WHEEL 4) LEFT SIDE 3) RIGHT SIDE 5) NO FALL</p> <p>94. DID YOU FALL</p> <p>1) ON TOP OF OR UNDER THE BIKE 2) AWAY AND FREE FROM THE BIKE 3) DID NOT FALL</p> <p>95. RESULT OF ACCIDENT</p> <p>1) PERSONAL INJURY 2) BIKE DAMAGE 3) PROPERTY DAMAGE 4) 1 AND 2 6) 2 AND 3 5) 1 AND 3 7) 1, 2, AND 3</p> <p>96. WORST INJURY</p> <p>1) SCRAPE, CUT 5) LACERATION REQUIRING STITCHES 2) BRUISE 3) SPRAIN 6) CONCUSSION 4) FRACTURE 7) OTHER</p> <p>97. PART OF BODY RECEIVING WORST INJURY</p> <p>1) HEAD, FACE 6) LEFT LEG, FOOT 2) LEFT ARM, HAND 7) RIGHT LEG, FOOT 3) RIGHT ARM, HAND 8) GROIN 4) CHEST, STOMACH 9) OTHER 5) BACK, HIP</p> <p>98. INJURY RESULTED FROM DIRECT CONTACT WITH</p> <p>1) CAR BODY 5) SPOKES 2) GROUND 6) CHAIN 3) OBSTACLE 7) BIKE FRAME 4) HANDLE BARS 8) OTHER</p> <p>99. INJURY TREATED MAINLY BY</p> <p>1) HOSPITAL 4) SOMEONE AT HOME 2) DOCTOR 5) MYSELF 3) FIRST AID 6) NO TREATMENT</p> <p>100. AMOUNT OF RIDING RIGHT AFTER ACCIDENT</p> <p>1) NONE 3) 1/2 HOUR 5) 2 HOURS 2) 1/4 HOUR 4) 1 HOUR OR MORE</p> <p>101. BIKE REPAIRED BY</p> <p>1) MYSELF 4) MECHANIC 2) SOMEONE AT HOME 5) BIKE RUINED 3) BIKE SHOP 6) BIKE WAS OK</p> <p>102. ACCIDENT REPORTED TO</p> <p>1) THE POLICE 3) BOTH 2) THE INSURANCE CO. 4) NEITHER</p>
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## APPENDIX A—Continued

### LOCAL BICYCLING CONDITIONS

DESCRIBE THE FOLLOWING CHARACTERISTICS IN GENERAL OF LOCAL BIKE ROUTES OR LANES THAT YOU RIDE AS:

- 1) ADEQUATE
- 2) INADEQUATE
- 3) VERY INADEQUATE

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103. NUMBER OF ROUTES AVAILABLE	111. FREEDOM FROM PEDESTRIAN INTERFERENCE
104. LOCATION OF ROUTES	112. NUMBER OF TRAFFIC SIGNALS AND REGULATORS
105. CONTINUITY OR EXTENT TO WHICH DIFFERENT PATHS LINK TOGETHER	113. ENFORCEMENT OF BICYCLE "RULES OF THE ROAD"
106. MARKINGS AND SIGNS MAKING THEM EASY TO FOLLOW	114. LIGHTING FOR NIGHT RIDING
107. MAINTENANCE OF THE RIDING SURFACE	115. PROTECTION FOR PERSONAL SAFETY
108. SEPARATION FROM MOVING MOTOR VEHICLE TRAFFIC	116. PROVISIONS FOR STOPPING OR RESTING
109. CROSSING PROVISIONS AT INTERSECTIONS	117. NUMBER OF PARKING FACILITIES
110. SPACE ALLOWED FOR AMOUNT OF BICYCLE TRAFFIC	118. THEFT PROTECTION AT PARKING PLACES

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119. WHAT IS A DEFINITE ADVANTAGE OF "BIKE ROUTES" YOU RIDE?

ADVANTAGE: \_\_\_\_\_

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120. IDENTIFY A SPECIFIC PROBLEM OF BIKE RIDING AND A LOCATION WHERE IT OCCURS.

PROBLEM: \_\_\_\_\_

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LOCATION: \_\_\_\_\_

## APPENDIX B

### Exploration of Adult Bicycle Use—Phase IV

#### **Background**

For the past ten years Council research and program development have focused on bicycle use and accidents among elementary school age children. This activity has been brought to fruition most recently in the release of the first edition of "All About Bikes," an elementary school program that shows additional value as a precursor to driver education.

#### **Current Phase**

As many new bikes as new cars are being purchased this year—about ten million! Proposed solutions proliferate for accommodating the increasing number of serious adult cyclists effectively and safely in traffic. Little data, however, exists pertaining to the whos, whats, whens, wheres, and whys of this cycling activity. Through the cooperation of the concerned organizations the Council plans to collect such data by self reports of cyclists from bike clubs, college campuses, and random samples of cycling adults.

#### **University Participation**

Yours is one of 60 colleges that are requested to administer 100 bicycle questionnaires each in order

to represent all national census areas. While the enclosed forms may appear unwieldy at first, note that the multiple choice questions may be completed rather quickly and easily. In fact, respondents should not belabor any particular question.

#### **Procedure**

- (1) Have as many questionnaires as possible distributed to cyclists *in classroom settings* and returned by the end of class. This *or similar situations* will allow complete recovery of circulated forms.
- (2) Have the *remaining forms*, if any, handed out *to cyclists on campus*. Provide for their *return the following day*.
- (3) *Return the completed forms in the self-addressed envelope provided.*

Thank you,

Tom Chlapecka  
Research Associate  
National Safety Council  
425 N. Michigan Avenue  
Chicago, Illinois 60611



Publ: Accident Analysis and Prevention v8 n1 p45-50 (Feb 1976)  
1976 ; 10refs  
Availability: See publication

HS-018 459

### STATISTICAL EVALUATION OF THE EFFECTIVENESS OF "ALCOHOL SAFETY ACTION PROJECTS"

The United States Department of Transportation's Alcohol Safety Action Programs (ASAP) were evaluated by comparing motor vehicle crash fatalities in a number of communities with such programs with fatalities in similar communities without programs. The basic statistic used in the analysis was a proportion, calculated by dividing the number of fatalities in each ASAP area in a year by the combined number of fatalities in the ASAP and comparison areas for that year. Yearly variations in the proportions of ASAP area fatalities were graphed, and are included in a table. The fatal crash data for the areas studied revealed no significant reduction in the total number of crashes between communities with ASAP and those without. However, there was a significant change as measured by the National Highway Traffic Safety Administration's model in the relation between daytime and nighttime fatal crashes that followed the introduction of ASAP's. Since the probability that alcohol is involved in a fatal crash is much higher during nighttime than during daytime, and since the observed interaction corresponds to a decrease in the number of nighttime fatal crashes in comparison with daytime fatal crashes, it was incorrectly concluded that the ASAP's were responsible for the observed interaction and, therefore, that ASAP's reduced the number of nighttime fatal crashes. Appendices provide information on: areas included in the study; matched groups of comparison areas; population and fatality data for groups of areas with ASAP's and matched area groups; sources of fatality data for counties in the study; a regression model; and analysis of variance for the transformed fatality proportions for the comparison groups.

by Paul Zador  
Publ: Accident Analysis and Prevention v8 n1 p51-66 (Feb 1976)  
1976 ; 20refs  
Availability: See publication

HS-018 460

### A CRITIQUE OF THE PAPER "STATISTICAL EVALUATION OF THE EFFECTIVENESS OF ALCOHOL SAFETY ACTION"

A critique is made refuting Zador's claim (1976) that Alcohol Safety Action (ASAP) Projects, as large scale social programs, have been ineffective. The critique claims that Zador chose to study only a portion of one objective while ignoring the others. Furthermore, the data on which Zador derives his conclusions are based on less than half of the ASAP operations. Finally, the author did not review the evaluation reports of the individual projects, nor did he review or comment on other types of criterion data, such as roadside surveys of breath alcohol levels. Zador makes the basic error of concluding that since the specific statistical technique he used on a limited

portion of the data failed to find a significant effect, the ASAPs were ineffective as large scale social programs. In addition to the analysis of his own data on fatalities, Zador reanalyzed the National Highway Traffic Safety Administration data on nighttime versus daytime crashes, using his own statistical method. The power of the Zador experimental design is examined for its sensitivity relative to committing a Type II error and it is concluded that the acceptance of alternative hypotheses regarding ineffective ASAP programs are completely invalid. A comparison of Zador's fatality data with the ASAP reported fatalities in which significant differences were noted is presented. Comparison areas selected by Zador were assembled on the basis of population size, population growth, area type and geographic location. It is concluded that the comparison groups used were inappropriate for the study and had no value as "controls" for the ASAP groups.

by Penelope Johnson; Paul Levy; Robert Voas  
Publ: Accident Analysis and Prevention v8 n1 p67-77 (Feb 1976)  
1976 ; 10refs  
Availability: See publication

HS-018 461

### TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)

Test and evaluation phases of a Rohr Transbus program are described. Vehicle testing was conducted in an effort to analyze the integrity and other qualities of the new buses and to produce prototype transit buses which would encourage the public to increase the use of public transportation. An extensive program was also conducted to evaluate the public and transit authority acceptance of the new designs incorporated in the Transbuses. Three prototype buses underwent an extensive life cycle test on individual components, complete vehicle testing of all phases of performance and durability, and public and transit personnel evaluation. The original concept of selecting the best of the three buses has been set aside in favor of obtaining a basic set of specifications for the Department of Transportation around which any manufacturer may perform in designing a transit bus. From all indications, public acceptance of the Transbus is excellent. For handicapped individuals, the Rohr bus was equipped with a hydraulically operated ramp which extended through the entrance door for wheelchair boarding.

by Joe F. Atkins  
Rohr Industries, Inc.  
Rept. No. SAE-750735 ; 1975 ; 9p 8refs  
Presented at the West Coast Meeting, Seattle, Wash., 11-14 Aug 1975.  
Availability: SAE

HS-018 462

### IDENTIFICATION AND PROGRAMMING OF ROADSIDE HAZARD IMPROVEMENTS. INTERIM REPORT

A project was undertaken to identify those features of the roadside environment which constitute a hazard to the highway user. Previous emphasis on freeways has caused removal or modifications of existing roadside obstacles. Since

the types of improvements which are suitable for freeways are not directly applicable to the remainder of the highway system, this research effort is examining the nature of the problem on non-freeway facilities. Initial work on the project, including a review of the literature, a formalization of the concept of a roadside hazard, and an evaluation of the characteristics of single vehicle accidents are summarized. Field investigation procedures are also outlined, and the preliminary results of accident site investigations discussed. The applicability of photologs in evaluating roadside safety is examined. A preliminary structure for roadside hazard identification and correction is presented, and the tasks to be undertaken during the remainder of this research to finalize the evaluation procedure discussed. Tables include general statistics on single vehicle accidents; single vehicle fixed object accident study sites; accidents by type at study sites; and photographs of sites.

by Jerome Wm. Hall  
University of Maryland, Transportation Studies Center,  
College Park, Md. 20742  
Contract AW-75-148-46  
Rept. No. FHW A-MD-R-76-2 ; 1976 ; 183p 156refs  
Report for Jun 1974-Jun 1975. Prepared in cooperation with  
the Federal Hwy. Administration.  
Availability: Corporate author

HS-018 464

#### **STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT**

A study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame is reported. The report is divided into sections covering: selection of improvements for passenger cars for 1980 and 1985; individual manufacturer reviews from General Motors, Ford, Chrysler, American Motors, Volkswagen, Toyota, Nissan, Volvo, Fiat, Honda, Toyo Kigyo, and Audi; improvement in fuel economy for light duty trucks; and evaluation of individual technologies for vehicle, transmission, engine and acceleration performance improvements. After considering trends and factors, the change in fleet average fuel economy since 1967 was found to be approximately a 4% loss, and the change in new model fuel economy was approximately a 12% loss. The fleet average fuel economy was found to be higher than the new model economy, since many of the vehicles on the road are older models.

Department of Transportation; Environmental Protection Agency  
Rept. No. Technology-Panel-4 ; 1975 ; 165p 24refs  
Fourth of seven panel reports.  
Availability: Corporate authors

HS-018 465

#### **CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?**

An analysis of cognitive development as it relates to a child bicyclist's capacity for comprehending the traffic environment is reported. Information bearing on the role of cognitive development emphasizes experimentally derived data that seem to show children as severely limited in terms of their capacity to truly understand the traffic environment, its rules,

and hazards. Statistical data are included that demonstrate the disproportionate risk of accident involvement among younger cyclists. It is concluded that the cognitive development associated with the incompletely developed child are not enough to justify a minimum age of 13 years for cycling on public roadways, and note is made that excellent advocates exist for an even higher age. Imposition of a minimum age requirement is seen as the most effective way of improving safety and significantly reducing the number of young cyclists killed and injured. Results of a survey of 1,373 parents of 2-12 year old children, ages 5 to 13, in which the parents selected a minimum age of about 11 years are also reported; these results are interpreted as a measure of good to enthusiastic support of the minimum age idea.

by Lloyd N. Popish  
City of Santa Barbara, California, Transportation Div  
1975 ; 81p 22refs  
Supported by the State of California Office of Traffic Safety  
and the National Hwy. Traffic Safety Administration.  
Availability: Corporate author

HS-018 467

#### **ACCIDENT SOURCE COMPILATION. FINAL REPORT**

Rapid rail mass transit is one of the safest means of travel. Patron and employee safety is a function of inherent conditions, on-going repair and maintenance, and social factors. A compilation based on logic tree analysis to determine areas of potential safety concern is presented. Additionally, a priority listing of possible accident sources is included. The accident sources were developed by transit industry representatives and were subjectively ranked each element in terms of importance to safety consideration. In keeping with the tree arrangement, the degree of safety hazard was defined as "major" or "minor". These are then listed as exposure limited to "public", "employee", and "personal injury". Accident source areas are listed as: facilities, vehicles, and "personal injury".

by William M. Connell; Fred S. Greene  
Transit Devel. Corp., Inc., 1730 M St., N.W., Washington, D.C. 20036  
Rept. No. TDC-500-75-9; PB-246 246 ; 1975 ; 26p  
Availability: NTIS

HS-018 468

#### **EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY SITUATIONS**

The effects on driver performance of blood alcohol concentration (BAC) below 50 milligrams percentile were studied in two contexts: in a critical automobile driving situation involving emergency braking and evasive maneuvers; and in a second situation following the first one and featuring the sudden appearance of a man-shaped obstacle blocking the road. The subjects were twenty-six men, age 19 to 31, with a mean age of 24.5; the majority were university students. Six subjects took part in the pilot study and ten in each of the two phases of the main study. Drinking habits were similar in all subjects, with the consumption of alcohol a few times per month, with an amount equivalent to approximately 8 cubic centimeters of ethanol 100%. The experimental vehicle was a 1973 Ford Station Wagon. For the presentation of the stopping and evasive

the driver two red brake-lights were placed on the fenders. The car was equipped with a 35 mm camera inside the windshield which was triggered by the application of either braking or turning the wheel 60 degrees. A 500 meter closed section of a four-lane motorway was used as the test site. On the closed course, two separate settings of rubber pylons were arranged. The smaller setting was used for pretraining of the emergency braking and evasive maneuvers. The longer was used for training and testing and had eight emergency openings. The two phases of experiment were then run. The results indicate that the detrimental effects of alcohol were attained at a total BAC-average of 42 milligrams percentile. In the braking and maneuvering task, drivers under the influence of alcohol hit significantly more pylons and took significantly longer distances to stop. There was also a strong tendency for alcohol to impair performance in the surprise situation. Under the influence of alcohol, five drivers out of ten collided with the man-shaped obstacle. In the control (non-alcohol) condition, only one driver of ten collided with the obstacle.

by Hans Laurell  
 National Swedish Road and Traffic Res. Inst., (Statens Vaeg-  
 och Trafikinstitut) Fack 581 01 Linkoping, Sweden  
 Rept. No. 68A ; 1975 ; 28p 24refs  
 Sponsored by the National Swedish Road Safety Office.  
 Prepared in cooperation with the Danish Council of Traffic  
 Safety Res., and Karolinska Inst., Dept. of Alcohol Res.  
 Availability: Corporate author

HS-018 469

#### ANNUAL SPEED STUDY (ARIZONA)

The annual speed study for Arizona is reported. The study is conducted to determine speed distributions and trends on the state highway system. Speed samples were obtained using a radar speed meter and an unmarked pick-up with a camper. Thirty-three permanent stations throughout the State Highway System were sampled. All sample vehicles were recorded under conditions which theoretically would enable each driver to choose a speed without influences of geometric design, signing, vehicular congestion, inclement weather, or unsafe conditions. The resultant data were utilized to produce the various graphs, tables, and speed distribution curves shown in the report. These include: a definition of terms; station descriptions; station location map; sample size and vehicle speeds by station; numerical and percentage conclusions for interstate-rural, interstate-urban, primary-divided, primary-undivided, secondary, and non-federal aid; day/night speed charts for passenger cars; day speed charts for local and foreign passenger cars; cumulative day and night speed charts for passenger cars and trucks; passenger car 85th percentile speeds; passenger car speeds--day and night; composite speed trends interstate-rural, interstate-urban, primary, and secondary; and the percentage of day vehicles exceeding specified speeds. Throughout the booklet are scenic color pictures of Arizona.

Arizona Dept. of Transportation, Traffic Operations Services  
 1975 ; 108p  
 Cover Title: Arizona Annual Speed Study. Prepared in  
 cooperation with the Federal Hwy. Administration.  
 Availability: Corporate author

HS-018 470

#### AN EVALUATION OF EPIDEMIOLOGIC STUDIES RELATED TO ACCIDENT PREVENTION

The epidemiologic approach was first suggested as a tool for the study and prevention of accidents in 1948. Most epidemiologic accident research has been performed in the area of traffic accidents, rather than industrial accidents. The utility of epidemiologic methods for reducing occupational accidents lies mainly in the capability to define the nature and extent of the new problem area. As a research strategy, the approach has the following major shortcomings: failure to classify environments; no systematic use of the approach in practice; failure to study social and psychological indices of the host; failure to study the influence exerted by the socioeconomic environment; and too much concentration on broad descriptive survey results. To achieve its theoretical potential, future epidemiologic research must correct these flaws. Several cases which used descriptive epidemiology are reviewed, including an age analysis of agricultural accidents, and a survey of sugarcane-cutting accidents among Puerto Rican workers.

by Monica H. Schaeffer  
 Publ: Journal of Safety Research v8 n1 p19-22 (Mar 1976)  
 1976 ; 8refs  
 Availability: See publication

HS-018 471

#### FAMILY DISORGANIZATION AND TEENAGE AUTO ACCIDENTS

Studies reveal that teenagers account for a disproportionate number of traffic accidents and violations. Assuming that family disequilibrium affects adolescent driving, the study investigated the lifestyles and family relationships of 496 adolescents, age 16 to 19, and their parents in relation to their driving records. Family dysfunction and social stress were revealed as important in the causation of accidents in males, but not females. The only important predictor for females seemed to be exposure to risk or actual mileage driven. These preliminary studies give credence to the hypothesis that for males, auto accidents, like social deviancy, are symptomatic of family disorder. Females seemingly do not choose this method of expression of conflict perhaps due to sex-role limitations on aggressive behavior in girls. The authors present path regression analysis as a useful method for analyzing complex epidemiologic data. Tables show the contents of a 300-item family life questionnaire administered to the teenagers; a 20-item family life questionnaire administered to the parents; the relationship of accidents to selected characteristics in males; selected correlates of accidents by sex; an example of a path model for males; intercorrelations among selected predictors of accidents for males; a path regression model for males; and backward and forward decomposition of accident variance for males.

by Raymond Sobel; Ralph Underhill  
 Publ: Journal of Safety Research v8 n1 p8-18 (Mar 1976)  
 1976 ; 10refs  
 Availability: See publication

## INNOVATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS

Laboratory studies have shown curved markers to be more efficient at signalling traffic commands at acute-angle intersections than conventional flat markers. An on-site study was undertaken to compare the signalling efficiency of three marker types: a standard two-dimensional marker; a hooded standard marker; and a curved marker. The study site was a two street intersection at an 11 angle, with one of the streets controlled by a Yield sign. Results showed that the curved marker elicited a significantly higher percentage of correct responses than the two conventional signs in non-rush hour traffic when the driver was in the lane expected to yield. Similar results occurred when the data were averaged across traffic conditions, but not under rush-hour conditions when responses appeared to be nondiscriminative of marker type. There were no significant differences among marker types when the driver was in the thoroughfare lane. In order to determine the potential applicability of the curved marker, measurements were made from aerial mosaics of all of the intersections on a major Alberta, Canada highway. There were more acute-angle than right-angle intersections controlled by markers on this highway, and hypothetical projections of error response with flat and curved markers indicated that curved markers would improve signalling at a substantial proportion of the intersections. The combined results indicate a need for additional on-site study. Figures include: flat and curved markers viewed from three angles; like graphs of the mean proportion of error responses to flat and curved markers at each of nine viewing angles in dynamic and static laboratory tests; photograph of intersection used in on-site study; and a graph of potential errors of response based on the mean proportions. Tables include: frequency of intersection angles recorded in ranges; percentages of correct responses to each of the three marker types in non-rush hour and rush hour traffic; and percentages of acute-angle and right-angle intersections controlled by stop and yield or merge markers.

by T. M. Nelson; C. J. Ladan; D. D. Kuchinski  
 Publ: Journal of Safety Research v8 n1 p23-9 (Mar 1976)  
 1976 ; 7refs  
 Availability: See publication

## AEROSPACE STRUCTURAL ADHESIVES. FINAL REPORT

A study was made of problems associated with the use of aerospace structural adhesives. Consideration is given to the state of the art and future needs in synthesis and formulation of adhesives. The role of interfaces is discussed from a physical chemical point of view. Manufacturing and processing aspects of adhesive use are considered. Data and theory are given for mechanical behavior, permanence, and related areas. Problems of design analysis, specification, and test methods are taken up. Performance, reliability, strategies, and future applications conclude the study. Recommendations for activity in need of early consideration are offered: development of better means to assemble and communicate information; development of a good adhesive manual; extension of research on the application of fracture mechanics; development and perfection of adequate nondestructive test methods; development of a better adhesive system; expansion of basic studies of physical and mechanical properties; and continued develop-

ment and use of better techniques for design and adhesive-bonded joints.

National Res. Council, National Materials Advisory Board, 2101 Constitution Ave., N. W., Washington, D. C. 20418  
 Contract MDA-903-74-C-0167  
 Rept. No. NMAB-300; AD-787 040 ; 1974 ; 299p 94refs  
 Availability: NTIS as AD-787 040

## STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT

Four studies related to vehicle rear lighting problems are presented. The studies were concerned with the development of additional knowledge on the type of information which should be displayed on the rear of vehicles to the following vehicles which would be most effective in preventing rear-end crashes and maintaining a smooth flow of traffic. The studies consist of analyses of accident data, particularly concerned with trucks, for which no significant accident analysis has been completed at the time that the work was initiated. In addition, the ability of the drivers to comprehend innovative display formats, which were intended to provide specified types of information, was evaluated. Experimental studies were also carried out in the laboratory and on the road, concerning the ability of drivers to process information on relative velocity. It was determined that the basic information now presented by vehicle rear marking and signalling should be retained. In addition, evidence from the accident data indicated that four presence lamps, mounted in a rectangular array should be used to provide improved sensitivity to following-car drivers to changes in headway. A steady-state moving vehicle display should form part of a velocity-coded system in a few categories by the illumination of various numbers of lamps. The marking of parked vehicles and the effectiveness of current standards of vehicle rear marking requires further evaluation. A bibliography is included. Descriptions of the following are appended: the rear lighting system used in car and truck simulation; observer instructions for the study of interpretation of signals; a criterion for the study of spacing changes; instructions for the study of estimation of relative speed; and instructions for the study of estimation of time closure.

by R. G. Mortimer; E. R. Hoffmann; A. Poskocil; C. J. Jorgeson; P. L. Olson; C. D. Moore  
 University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109  
 Contract UM-7101-C128  
 Rept. No. UM-HSRI-HE-74-25 ; 1974 ; 218p 78refs  
 Includes HS-018 475--HS-018 478. Rept. for Mar 1974  
 Availability: Motor Vehicle Manufacturers Assoc. of America, Inc., 320 New Center Bldg., Detroit, Mich. 48202

## ACCIDENT DATA ANALYSIS

A survey was conducted to determine whether accident reports contain any indications of the importance of various traffic signals and can offer any insights regarding possible traffic signals of benefit. Statistics were taken from the National Safety Council and county accident files, and tables were prepared for comparison of information. Data indicated that

between vehicles oriented in the same direction constituted at least half of all traffic accidents. In almost half of the same-direction accidents involving a fatality, one vehicle was parked, stopped, stopping or starting. Parked vehicles were involved in about 5% of all two-vehicle crashes in a Washtenaw County, Michigan, accident sample. The relative speed between pairs of vehicles moving in the same direction was positively related to the probability of a rear-end crash occurring. On grades, rear-end collisions increased compared to other two-vehicle collisions, showing the effect of variability in traffic speed. The rates of rear end collisions are higher on wet roads than dry and higher still on wet roads at night. Rear-end crashes into parked vehicles more frequently resulted in injury at night than day, indicating that such collisions are more severe at night. Most rear-end injury crashes into parked vehicles occurred at night (62% on dry, 74% on wet roads). Other types of rear-end injury crashes occurred much less often at night (30% on dry, 39% on wet roads). Turning vehicles appeared to be involved in more than the expected frequency of rear-end injury crashes, as compared to non-turning vehicles. Trucks, especially tractor-trailers, were found to be overinvolved in fatal rear-end collisions compared to cars, being the striking vehicle in 20% and struck vehicle in 27% of interstate highway fatal accidents. Twenty-eight percent of the rear-end collisions on interstate highways occurred on up-grades, compared to 5% on downgrades. Of these collisions, 88% involved trucks, with the truck being the struck vehicle 82% of the time. When fatalities occurred in car-truck accidents, 96% were occupants of the car.

by R. G. Mortimer; E. R. Hoffmann; A. Poskocil; C. M. Jorgeson; P. L. Olson; C. D. Moore  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109  
Publ: HS-018 474 (UM-HSRI-HF-74-25) Studies of Automobile and Truck Rear Lighting and Signaling Systems, Ann Arbor, 1974 p6-48

1974  
Availability: In HS-018 474

HS-018 476

#### INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)

A laboratory investigation was undertaken to determine whether naive drivers could reliably interpret the meaning of unique signals as presented by various truck and automotive rear lighting systems. A total of 100 subjects were tested in the experiment, 47 viewing 14 lighting system on trucks and 53 viewing 13 lighting systems on automobiles. Subjects were shown film segments of each system, with each segment showing a different signal or combination of signals. They were then asked to mark down what signal codes they believed were contained in the film segments. It was found that drivers readily identified the intended meaning of the novel rear lighting displays tested, which provided high deceleration, velocity, stopped, and slow-moving vehicle signals. Some conventionally used signals, such as hazard warning signals and back-up signals, were not identified as frequently as expected.

by R. G. Mortimer; E. R. Hoffmann; A. Poskocil; C. M. Jorgeson; P. L. Olson; C. D. Moore  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109  
Publ: HS-018 474 (UM-HSRI-HF-74-25) Studies of Automobile and Truck Rear Lighting and Signaling Systems, Ann Arbor, 1974 p50-66  
1974  
Availability: In HS-018 474

1974  
Availability: In HS-018 474

HS-018 478

#### PERCEPTION OF RELATIVE VELOCITY

An extensive review of the literature was undertaken, and three studies conducted in an effort to determine the cues to the detection of relative velocity as well as the sensitivity of normal observers to these cues. Results indicate that the thresholds for angular velocity are about .0035 radians per second, and that relative velocity can be perceived in short-glance times when it is above threshold. Drivers were able to scale relative velocity into just under three categories, but lead-car absolute velocity into about five categories. However, in car-following simulator tests, the drivers transmitted little information of relative velocity. At low frequencies of variation in velocity of the lead car (less than .05 Hertz) the driver of the following vehicle appeared to use a velocity response to detected changes in headway. At higher frequencies, velocity response was used to detect changes in relative velocity. It was determined that drivers' perception of relative speed was so poor that they could do little more than identify whether the gap between theirs and a lead car was opening or closing.

by R. G. Mortimer; E. R. Hoffmann; A. Poskocil; C. M. Jorgeson; P. L. Olson; C. D. Moore  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109  
Publ: HS-018 474 (UM-HSRI-HF-74-25) Studies of Automobile and Truck Rear Lighting and Signaling Systems, Ann Arbor, 1974 p78-161

1974  
Availability: In HS-018 474

HS-018 480

#### ROADSIDE SAFETY DESIGN

Concepts and designs in roadside safety design are discussed and illustrated with photographs. The following construction and design categories are included: cross section and slope grading; bridges; drainage appurtenances; gore areas; signing; delineation; lighting; guardrail; and impact attenuation. Over 800 photographs comprise the concept illustrations.

Federal Hwy. Administration  
1975 ; 266p  
Availability: Corporate author

HS-018 481

#### EXPERIMENTAL VALIDATION OF THE CALSPAN TIRE RESEARCH FACILITY. VOL. 1. FINAL REPORT

A correlation program was conducted to ascertain the measure of agreement between tire data produced on Calspan's Tire Research Facility (TIRF) and correspondent data obtained from eight other program participants. The program was designed to accommodate comparisons with all of the participating facilities (flatbed testers, drums, and road testers); and contained low, medium, and high speed cornering and braking tests on dry and wet surfaces. Almost all tests were run with two types of tires: a bias-belted tire G78-15; a radial tire JR 78-15; and a few runs assigned to an American Society of

Testing and Materials (ASTM) Traction Test Tire, the proposed E249e73. From the submitted data, five tire performance functions were selected for comparison and the results are displayed. The functions are: cornering force and aligning torque as functions of slip angle and of inclination angle; and traction force as function of longitudinal slip. Comparisons were achieved by evaluating nearly 500 matching sets of data (one set always from TIRF) in terms of least-square fits (quadratic spline), stiffness data (cornering, camber, aligning), offset data, and peak and slide data. An attempt to detect a systematic influence of the type of testing machine on the stiffness data failed although it seemed that the data generated on flatbed testers showed less scatter and were clustered more closely than the data obtained from drums and road testers. TIRF data were always close (plus or minus 3%) to the mean data of all data collected from the spectrum of existing tire testers. The results suggest that within the evaluated performance range, TIRF showed itself to be a valuable and valid test facility. Data correlation graphs from the following sources are presented: Firestone, Ford, General Motors, General Tire, Goodrich, Goodyear, Highway Safety Research Institute, and Uniroyal.

Calspan Corp., Buffalo, N.Y. 14221  
 Rept. No. ZM-5269-K-1; CAL-7309-C235 ; 1973 ; 59p  
 Supported by the Motor Vehicle Manufacturers Assoc. of the United States, Inc., and the Rubber Manufacturers Assoc., Inc. Vol. 2 (not available at NHTSA) contains all raw data used in the correlation program.

Availability: Reference copy only

HS-018 482

### THE HIGHWAY KILLER-COMBINATION

There seems to be an increase in the number of traffic accidents and fatalities which are related to drinking and drug-taking in combination, among teen-agers and young adults. Since the use of alcohol, marijuana, and "polydrug" combinations is reported to be reaching epidemic proportions, the National Institute of Drug Abuse recently began a national survey. The United States Public Health Service has also been making a study of the problem in some California communities. The study has disclosed that more than one-half of all students in San Mateo County in grades nine through twelve consume alcoholic beverages at least ten times a year, and that more than one-fourth of that grade-group drink at least fifty times a year. The juvenile drug taking and drinking problem appears to cut across racial and economic lines, with increased usage of alcohol and drugs having little relationship to either poverty or affluence. Many school officials, counselors, and probation officers attribute the increased usage to parental indifference or bad examples set by the parents themselves. Some parents even encourage drinking, thinking it will keep the children away from other drugs. The combination of tranquilizers, pep pills, and alcohol is especially dangerous, resulting in mental disorder and sometimes death. Suggested measures for dealing with the problem include education as to the dangers of alcohols and drugs, a "hardline" approach in dealing with drug traffickers, and public awareness of the rise of drug and alcohol abuse and traffic fatalities.

by Wm. L. Roper  
 Publ: California Highway Patrolman v40 n1 p4-5, 24-5, 28-9,  
 32-3, 36-7  
 1976

Availability: See publication

HS-018 483

### OCCUPANT PROTECTION IN VEHICLE ROLLOVER

Studies on occupant protection in vehicle rollover were conducted using an Escort II, a Mark III Cortina, a Mark I Capri, and a Consul 4. Phase One testing was carried out with unrestrained dummies. At the end of Phase One, legislative trends to enforce wearing of seat belts became more evident. Phase Two and Three tests were conducted using restrained dummies with Ford production static seat belts. Phase Two was completed by tests on weekend and strengthened vehicles. Phase Three commenced with tests on padding materials. Instrumentation and fitting of the dummies was carried out at the laboratories using Alderson VIP 50A dummies. High speed cine cameras incorporating a timing device were used inside the vehicle and around the test area perimeter. Vehicle modifications consisted of: weakening body above the waist line; strengthening the body of the dummy above the waist line; replacing the conventional glazing system with direct glazing system; incorporating foam mouldings in roof areas; mounting foam absorbing panels to the front doors; and fitting seat side restraints. Tests involved: roof crush; rollover; and energy absorbing padding tests. For unrestrained occupants the main injuries would have been severe limb injuries related to partial ejection through the screen and door glass apertures. For restrained occupants, the use of seat belts reduced limb ejection, and changed the injury pattern from limb ejection to head impacts with the vehicle interior. It was found that repeatability of overall vehicle dynamics and damage for rollover was fairly consistent; changes to the normal roof strength had less significant effects on occupant protection than the use of seat belts and interior padding; and weakening of the roof structure did not reduce the number of rolls. Attachment include: drawings and photographs of each of the test cars used; photographs of the dummies; and a table of significant events during rollover tests for occupants with and without seat belts. Graphs of vehicle displacement and angular velocity, dummy head velocity and acceleration levels, sample results from energy absorbing padding tests using a pendulum head form impact rig, and force/deformation graphs for the various vehicles used in the tests are included.

by K. Stone  
 Ford of Britain, Technological Res.  
 Contract CON-2598-SV  
 1975 ; 47p 3refs

Prepared in cooperation with the Motor Industry Res. Assoc.  
 Availability: Corporate author

HS-018 484

### SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT

The current expression of the techniques and methods category of the Urban Mass Transportation Administration's demonstration activity is described. Transit demonstration projects undertaken in previous years are reviewed. Recently completed and current demonstration projects are described and project results from similar demonstrations are compared. The comparisons are made by grouping projects according to the program objectives addressed: decrease transit travel time; increase transit reliability; increase transit coverage; increase transit vehicle productivity; and improve the mobility of transit dependents. Demonstrations are categorized as either experimental (those intended to develop and test concepts to the point they merit widespread use) or exemplary (those con-

HS-018 490

ducted to achieve more widespread diffusion of proven concepts and techniques). Independent activities carried out in support of the demonstrations are described, such as the development of evaluation guidelines and improved methodologies for demonstration evaluation, analytical studies in support of the development of experimental demonstrations, and case studies of independent local innovations. Information dissemination mechanisms and activities intended to facilitate more widespread knowledge of effective approaches to improving transit are discussed. A detailed description of each demonstration project including the objectives, history, status, results, evaluation and conclusions is appended.

by P. Benjamin; R. Casey; C. Cofield; C. Heaton; D. Kendall; J. Misner; H. Simkowitz  
Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142  
Rept. No. DOT-TSC-UMTA-76-1; UMTA-MA-06-0049-75-2 ; 1975 ; 243p refs  
Report for fiscal year 1975.  
Availability: NTIS

HS-018 486

#### **BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADIAN DRIVERS. INTERIM REPORT**

Some of the major findings of the 1974 National Road Side Survey of Nighttime Canadian drinking-driving habits are summarized. Almost one quarter of night drivers in Canada drink and drive, and one in twenty drivers at night has a blood alcohol level in excess of .08. The survey was conducted on Wednesday, Thursday, Friday and Saturday nights for twelve weeks and involved 9,774 drivers across Canada. Results indicated that the chances of meeting a drinking-driver on the road are twice as great between the hours of 1:00 am to 3:00 am than between the hours of 10:00 pm to midnight. About 22.9% of the nighttime drivers sampled had been drinking prior to driving, 13.2% were probably impaired and 4.8% were found to be legally impaired. The percentage of drinking-drivers and legally impaired drivers appeared to be of equal seriousness in all regions of the country. There did not appear to be any difference in the driving after drinking behavior between drivers in urban locations and those in rural locations. The percentage of drinking or impaired drivers was almost as great in inclement weather as in clear weather. On wet/icy roads, slightly smaller percentages of drivers were observed who had been drinking or were legally impaired. The incidence of legally impaired drivers did not decrease on roads with high posted speed limits. The lowest impairment percentage was observed on roads with a posted speed limit of 30 mph or less. Except for a category of 50 miles or more, the percentage of drivers who had been drinking is independent of the length of the trip. The percentage of male drivers who had been drinking was approximately double the percentage of female drivers who had been drinking or who were impaired. Percentage of drivers in this category did not seem to vary with level of education, but was 5% higher among unemployed drinking-drivers. Divorced or separated drivers also had a higher representation than those who were widowed or married. The largest percentage of drivers who had been drinking and who were legally impaired was observed among those 30-34 years of age. Slightly higher percentages of drivers who had been drinking wore

seatbelts or restraining devices than those who had not been drinking.

Ministry of Transport, Road and Motor Vehicle Traffic Safety Branch, Ottawa, Ont., Canada  
1975 ; 09p

Report for May, 1975. Includes News Release, Blood Alcohol Levels of Night Drivers in Canada dated 20 Jun 1975.  
Availability: Reference copy only

HS-018 487

#### **HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT**

A review with the design of diversion signs intended to persuade motorists to shift from a congested to a less congested route is presented. Studies of driver behavior were reviewed, including: origin-destination studies indicating the objective route characteristics which make a particular roadway path attractive to the driver; economic studies of the dollar value of time indicating the influence of economic factors on route choice; and studies of drivers' attitudes towards route diversion. Design principles are suggested for signs of route diversion, ramp diversion, and freeway condition diversion. A summary of major diversion projects is included. Various signs are illustrated.

by B. G. Knapp; J. I. Peters; D. A. Gordon  
Federal Hwy. Administration, Traffic Systems Div., Washington, D.C. 20590; Catholic Univ. of America, 620 Michigan Ave., N.E., Washington, D.C.  
Contract FH-11-8001  
Rept. No. FHWA-RD-74-22 ; 1973 ; 107p 53refs  
Availability: NTIS

HS-018 490

#### **HANDLING TRAFFIC CASES: A BETTER WAY**

An explanation of the operation of the Administrative Adjudication Bureau (AAB) of the New York State Department of Motor Vehicles in handling traffic cases is presented. Through the AAB, traffic offense adjudication has been separated from the mainstream of the criminal court, and coordination licensing and adjudication authorities has been greatly improved. As a result there has been a dramatic reduction of criminal court congestion, increased efficiency in traffic case processing, simplified methods and procedures for the convenience of motorists, reduction of excessive in-court police time, elimination of plea bargaining, and imposition of more uniform and appropriate sanctions. The separate elements of traffic offense adjudication (law enforcement, identification and case preparation, decision-making, sanctioning, compliance, and review) are all invested in an administrative approach where responsibility for all parts of the process, exclusive of law enforcement, goes to the AAB, the administrative agency.

New York State Dept. of Motor Vehicles, Administrative Adjudication Bureau  
Contract J-LEAA-014-74  
1975 ; 19p  
Availability: National Criminal Justice Reference Service, P. O. Box 24036, S.W. Post Office, Washington, D.C. 20024

HS-018 490

HS-018 491

## NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU

A new method in New York State for traffic offense adjudication is discussed. Traffic offense adjudication is separated from the mainstream of the criminal court, and coordination between licensing and adjudication authorities has been greatly improved. As a result there has been a dramatic reduction of criminal court congestion, increased efficiency in traffic case processing, simplified methods and procedures for the convenience of motorists, reduction of excessive in-court police time, elimination of plea bargaining, and imposition of more uniform and appropriate sanctions. The organizational and procedural changes involving both the courts and the Department of Motor Vehicles to which these achievements can be traced are fully described.

by Andrew Halper; John McDonnell

Abt Associates Inc.

Contract J-LEAA-014-74

197? ; 11refs

Availability: GPO \$2.65, stock no. 027-000-00301-3

HS-018 492

## DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES

Traction-slip curves obtained from drawbar pull tests were applied to determine values of the adhesive parameters controlling the peripheral forces of rubber tires rolling on concrete. The method is based on an analogy with soil shear strength characterized by cohesion, the angle of internal friction, and the tangent modulus of the derived shear-deformation curve. The peripheral force generated by a tire rolling on concrete is the total force required to shear the interlocking elementary particles in the contact patch. The adhesive parameters derived using this method are average values expressing the effect of all factors which contribute to producing peripheral force. Tables provide examples of the values calculated from traction-slip values, and parameters of the system.

by G. Komandi

Publ: Journal of Terramechanics v12 n3/4 p109-17 (Dec 1975)

1975 ; 1ref

Availability: See publication

HS-018 493

## TIRE DESIGNS FOR MOBILITY--USSR

The Soviet Union (USSR) has developed several types of tires to increase the mobility of wheeled vehicles. Five of these design types are described with characteristics, models, sizes, and construction details noted. They are: high pressure or highway tires; adjustable inflation pressure tires; low profile tires; arched tires; and air rollers or rolligon tires. The USSR feels that the introduction of adjustable inflation pressure, low-profile and arched tire designs solves the problems of transport vehicle movement under medium difficulty cross-country conditions. This is significant because, so far as can be determined, the term medium difficulty is their mobility

requirement for wheeled heightened mobility military vehicles. Based on this, it is anticipated that in the future radial tire inflation systems and adjustable inflation pressure tires will continue to be the backbone of the Soviet soil mobility. The use of the low profile adjustable inflation pressure tire will expand to cover most of their general military transport fleet. These tires may include design radial cord construction. Arched tires may also be employed. USSR researchers feel that the problem of wheeled vehicle movement under difficult cross-country conditions has been solved for any category of land vehicle. Air rollers used in various configurations hold promise in this area, and use in the roadless far north and eastern portions of the USSR has already started.

by D. B. Warner

Publ: Journal of Terramechanics v12 n3/4 p247-53 (Dec 1975)

Availability: See publication

HS-018 494

## NEW DEVELOPMENTS IN PISTON RINGS FOR MODERN DIESEL ENGINE

Unpublished data on new coating developments, new ring designs, and design considerations for the modern diesel engine are presented for the first time. Data on the state of the art of compression ring coatings along with technical data on new generation coatings are included as well as data on ring designs and/or design considerations which can be used to improve engine performance and life with respect to blow-by and oil control. Illustrations include: a two-ring combination used in four-stroke cycle, medium-duty diesels; a two-ring combination used in four-stroke cycle, high-speed V-type medium-duty diesel engines; RC-2 coated compression ring usage in diesel engines; chrome-plated air-coated compression ring usage in medium-duty diesel engines in various test fixtures; a porosity graph for plasma-applied and RC-4 coating and hard chrome plating; graphs of the same coatings showing tensile strength, hardness, fatigue strength, bore wear, compression ring wear; and cyclic fatigue curves of various nodular cast irons. Appendices describe the thermal shock procedure and parameters and tensile and fatigue test specimens.

by H. E. McCormick; R. D. Anderson; D. J. Mayhew; Rychlewski

T.R.W. Inc., T.R.W. Piston Ring Div.

Rept. No. SAE-750769 ; 1975 ; 32p 15refs

Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 495

## INVESTIGATIONS INTO LIGHT TRAFFIC 2

Investigations into the use and marketing of pedestrian reflectors are presented. A total of 276 stores at 22 localities in the United States and Canada were studied. An interviewer determined if the types of reflectors on display in the store, the types of reflectors and how they were displayed. The person in charge of reflector acquisition was also interviewed. In addition, 2,694 persons in the same localities completed a questionnaire. A completed interview form was returned completed by 76%. The interviewees were asked about the rate of

their knowledge about the use of reflectors, and about reflectors and their use. Opinions about reflectors at local shops were also examined. That: 56% of the stores had reflectors available; least available at department stores and service stations (90-100%) and least available in self-service in rural areas, the supply was more uniform in types; the most common reflector product was 'pe reflector; reflectors were best displayed at ns; the most important reason given for not ors was low demand; 78% of the interviewees owned a reflector; 46% said that they always r; the rate of use is lower in towns than in rural 's attitudes towards the use of reflectors were than men's, as were the young (under 20 years) e old (over 50 years); 99% thought the use of necessary and 80% thought it should be made id tapes of figures fixed in clothing were con or children and pendant-type reflectors were con or adults.

en  
Central Organization for Traffic Safety, Res. obertinkatu 20, 00120 Helsinki 12 Finland kenneturva-18 ; 1976 ; 68p 4refs  
Corporate author

## RE DIESEL ENGINE TESTING USING TIONAL FACTORIAL TECHNIQUE TO OIL CONTROL

ries has been run since 1966 on piston-ring-liner which will reduce oil consumptions to less than ie consumption for small bore diesel engines. The a was compiled and is presented in a series of ta f the potential factors studied are specific to each ome are general to all engines. A factorial plan is 1 tests are arranged by varying two or more fac efully balanced fashion. This includes testing on rings, oil rings, internal rings, clearance, grooves, s and tension. It is important to have proper iners to make the piston rings work properly.

hepler; Edward F. Willem; Erwin C. Brunke Inc.  
SAE-750770 ; 1975 ; 15p 2refs  
the SAE Off-Highway Vehicle Meeting, Wisc., 8-11 Sep 1975.  
SAE

## ST EXPERIENCE WITH NEW NIC GOVERNOR

electric governor system has been developed for to a wide range of rotating machinery. This new as application potential to any system requiring ed control or automatically variable speed control, electrical generating equipment. The governor con linear proportional solenoid controlled with large ated circuits packaged for direct mounting on the e of the primary objectives identified early in the it program was to overcome identifiable user cond ing the unknown and supposed complication of

electronic controls. The governor, through field tests, proved to be a simple, reliable design. There is strong evidence that the flexibility and broad capability of electronics will penetrate the entire range of rotating machinery control, and the governor is a clear step in achieving this goal. Some of the equipment used in the 80,000 hours of in-service field testing of the governor system is illustrated with photographs.

by E. L. Whitford  
Barber-Colman Co., Precision Dynamics Div.  
Rept. No. SAE-750771 ; 1975 ; 12p  
Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

HS-018 503

## NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES

From engine test results, methods can be derived for reducing visible emissions of diesel engines, particularly under operating conditions which so far are not yet subject to environmental protection legislation. It is general practice, when starting a diesel, to inject excess fuel independent of ambient and engine temperatures and regardless of whether this is necessary or not. It has been demonstrated that excess fuel should only be injected when starting a cold engine at ambient temperatures below freezing point and that the quantity of excess fuel should increase with falling temperature, reaching its maximum at the minimum engine starting temperature. The excess fuel quantity injected can be controlled with the aid of a wax element, so that, when the engine is warm, only the full load fuel quantity is injected. This eliminates the well-known cloud of black smoke emitted when starting a warm engine and considerably improves smoke emission when accelerating at low engine speeds. A burner starting aid of simple design and fully automatic operation is described which has been newly developed and is used to suppress or eliminate the emission of white and blue smoke during cold start and warm-up. Graphs are included which illustrate engine starts under different ambient temperatures and starting times, and the effect of various fuel inputs on engine start up. A flow diagram of the electric circuitry of the burner starting aid, a fuel flow diagram, and photographs of the burner flame at low and high engine speeds are provided.

by G. Fraenkle; H. O. Hardenberg  
Daimler-Benz AG (Germany)  
Rept. No. SAE-750772 ; 1975 ; 10p 5refs  
Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

HS-018 506

## SNOWMOBILE HANDBOOK. LAWS AND REGULATIONS

A book of regulations intended to create understanding of the rights and responsibilities of the snowmobile owner and operator in the State of Connecticut is presented. Topics include a list of environmental responsibilities, the state policy which balances the interests of snowmobile users against those of other citizens, and some of the ways in which snowmobiling can be considered a nuisance. Snowmobile safety tips, Connecticut policy and regulations and pertinent State laws, and

HS-018 507

reciprocity agreements with other states in terms of snowmobile registration are also covered. Final tips for snowmobile users include: a wind chill chart; trail signs; the snowmobile code of ethics; and a list of nationally accepted distress signals.

Connecticut Motor Vehicle Dept., Wethersfield, Conn. 06109  
1973 ; 20p  
Includes two page handbook revision dated December, 1975.  
Availability: SAE

HS-018 507

### INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

Three alternatives for improving automobile fuel efficiency are examined. Two would involve reducing vehicle weight by replacing iron and steel with lighter aluminum or plastic. The third would change the mix of car sizes so that more small, light weight vehicles would be produced. Major emphasis is placed on describing potential automobile design changes for each of the alternatives and on analyzing several aspects of the interindustry and macroeconomic impacts. Industry output and employment changes are examined using an input/output model. Changes in output from the energy industries for each of the alternatives are analyzed and presented in dollar value rather than in units of energy. The input/output model is further used to examine impacts on the gross national product (GNP) and national employment. As proper groundwork for an analysis of impacts, an extensive discussion of the automobile industry and its importance in the United States economy is first presented. The industry and its suppliers, the industry's contribution to the GNP, and material usage in automobiles are covered.

by Melvyn Cheslow  
Urban Inst., 2100 M St., N.W., Washington, D.C. 20037  
Grant NSF-G1-40615  
Rept. No. Working-Paper-1216-3-2 ; 1975 ; 78p 39refs  
Availability: Corporate author

HS-018 508

### NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

Performance requirements and methods of test for helmets to be worn by drivers and passengers of surface vehicles are established. Four crash helmets, size 7 1/4 and selected at random, will constitute a test sample. The procedures for testing peripheral vision, impact attenuation, penetration resistance, and retention system static strength are explained. Drawings of test equipment setups are provided.

National Inst. of Law Enforcement and Criminal Justice, Washington, D.C. 20531  
Rept. No. NILECJ-STD-015.00 ; 1975 ; 15p 3refs  
This standard was formulated by the National Bureau of Standards, Law Enforcement Standards Lab. Technical research was performed by personnel of the National Bureau of Standards, Measurement Engineering Div.  
Availability: Corporate author; GPO, \$0.35, stock no. 027-000-00347-8

HS-018 509

### ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATION OCCUPANT CRASH PROTECTION

Estimates of the effectiveness of seat belts, which reducing motor vehicle occupant deaths vary widely, occur 50% less often to belted compared to non-belted occupants in crashes, according to previously unanalyzed data from three states (Arizona, Nebraska, and Virginia) in recent years. A recent claim that seat belts reduce occupant deaths 75% has been shown to be based on a fundamental systematic error. Surveys of belt use in 1975 United States (U.S.) cars indicate that two-thirds of drivers were not using belts. Previous widespread adoption and enforcement of belt use in the U.S. are not encouraging. It is concluded that reductions in fatal and other injuries would result from adoption of requirements mandating passive protection for front seat occupants in crashes with forward deceleration.

by Leon S. Robertson  
Insurance Inst. for Hwy. Safety, Watergate 600, Washington, D.C. 20037  
1976 ; 24p 37refs  
Availability: Corporate author

HS-018 510

### AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY

A study was conducted to establish whether front-seat occupants were using the restraint system at the time of a crash occurrence, and what types and severities of injuries to occupants incurred. A total of 3,966 accidents were analyzed. These included all crashes in which a 1973- or 1974 model car was towed from the scene and an occupant was admitted to a hospital, plus a certain percentage of such towaway accidents not involving the removal of an occupant to a hospital. Information was provided for nearly 300 restraint system and occupant injury variables. Injuries were coded according to the Abbreviated Injury Scale (AIS). It was found that the restraint system (lap and shoulder belt) eliminates injuries greater than or equal to AIS-2 than a lap-belt-only system. A lap-belt-only system eliminates more such injuries than the use of a restraint; and the improvements of full restraint use over lap belts alone are not as great as might have been expected.

by Robert E. Scott; Joseph C. Marsh; Jairus D. Flanagan  
University of Michigan, Hwy. Safety Res. Inst.  
1976 ; 14p  
Sponsored by the Motor Vehicle Manufacturers Association  
Prepared in cooperation with Calspan Corp. and SRI  
Res. Inst.  
Availability: Motor Vehicle Manufacturers Association

HS-018 511

### DRIVER ERROR

An investigation of driver error was carried out in the vicinity of Crowthorne, England, to determine the most common errors; which were the most serious errors; and the locations at which they occurred. A number of subjects drove around a 28-mile route accompanied by a driver who monitored aspects of their driving behavior.

sequently, the behavior of 354 drivers was observed from a moving car along sections of the same route. Over the same period, time-lapse photography was used at specific points on the route to observe a larger number of drivers, 2,800 of whom were recorded committing driving errors. Each error was allocated a score on a five-point scale according to a subjective estimate of its level of danger. Eighty different types of driving error were recorded and classified in terms of frequency, severity and location. A high correlation was found between the observed errors together with their level of danger and the errors which led to injury accidents, and the location of observed errors and the locations at which injury accidents had occurred. Complete data tabulation and photographs of various errors are included.

by C. F. Harvey; D. Jenkins; R. Sumner  
 Transport and Road Res. Lab., Road User Characteristics  
 Div., Crowthorne, Berks., England  
 Rept. No. TRRL-SR-149-UC; ISSN-0305-1315 ; 1975 ; 60p  
 Availability: Corporate author

HS-018 512

### RISK TAKING AS A DECISION PROCESS IN DRIVING

Risk taking and decision making in driving is considered in terms of the theory of signal detection and the advantages of this consideration are discussed. Data is analyzed which was obtained from an experiment conducted at the University of Queensland, Australia, in which signal detection measurements of the performance of drivers in negotiation of gaps were obtained. Fourteen owner-drivers of standard Volkswagen cars were asked to drive through gaps formed by 1.2 meter posts in their own cars. The driver's judgement of the gap, his/her ability to negotiate it, and the driver's confidence in his own ability were rated. Gap widths were varied from the exact width of a standard Volkswagen to 5, 10, or 15 centimeters more. Each driver made 20 circuits of the test area passing through four gaps on each circuit, thus completing 80 gap trials in all. The possible relevance of driver risk taking, as analyzed in signal detection terms, to general road safety improvement measures is also discussed. Experimental results suggest that some drivers are able to maintain over a range of conditions of visual uncertainty a specific accuracy in assessing their prospect of success at making a maneuver if they should attempt it. It is implied that drivers adjust their risk acceptance criterion to the detriment of attempts to reduce the actual danger level.

by L. R. Newsome  
 Transport and Road Res. Lab., Road User Characteristics  
 Div., Crowthorne, Berks., England  
 Rept. No. TRRL-SR-81-UC ; 1974 ; 17p 11 refs  
 Availability: Corporate author

HS-018 513

### TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES

Mental and physical stress or "task load" incurred in the operation of a motor vehicle was investigated. Emphasis was placed on the investigation of the nature of overloads in driving task demands. Methods of assessing driving task load were developed and evaluated, with the ultimate aim of suggesting

remedial measures to minimize the occurrence and effects of overloads. The MOTOPROBE was developed to permit the simultaneous recording of the following variables: variables relating to the environment as coded by an observer; the driver's cognitive function in terms of the task load imposed by driving; measures of autonomic nervous system activity as a reflection of task load; and vehicle variables. This portable equipment system was then used to evaluate task loads on nine male subjects driving their own vehicles over four standard traffic routes of significantly different complexity. Analyses of variance on the driving task load measures show that heart rate, as well as measures of variability for both heart rate and verbal tapping, produce significant discrimination among the four traffic routes used. Attention tasks scores discriminated between only the extremes of difference in traffic complexity. Random generation produced no discrimination among the traffic routes used. It was concluded that of the four measures evaluated, cardiovascular and verbal tapping measures were shown to be the most useful for the assessment of driving task load and the most desirable for use in future experimentation in this field. These analyses of variance results were obtained for data summarized in equal spatial blocks only. In the case of temporal blocking of the same data, only heart rate discriminated between the four traffic routes. It was also found that analyses of variance in vehicle or environmental score totals produced a dramatically greater degree of significance for discrimination between traffic routes when the data were spatially blocked as opposed to temporal blocking. These results indicate that a task load/speed exchange function does exist, with drivers tending to minimize variance of task load across equal time units.

by G. A. Curry; D. J. Hieatt; G. J. S. Wilde  
 Queen's Univ., Dept. of Psychology, Kingston, Ont., Canada  
 Rept. No. CR-7504 ; 1975 ; 297p 136refs  
 Prepared for the Road and Motor Vehicle Safety Branch,  
 Ministry of Transport, Ottawa, Ont., Canada under contract  
 87150, 21 Jul 1970.  
 Availability: Ministry of Transport, Road and Motor Vehicle  
 Traffic Safety Branch, Ottawa, Ont., Canada

HS-018 514

### CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR

The characteristics of the diesel engine unit injector were studied both theoretically and experimentally. The experimental work was performed on an N-50 unit injector mounted in its position on the cylinder head of a 2-stroke-cycle Detroit Diesel Allison Division 2-53 engine. The unit injector was operated by a cam, push rod, and rocker arm, with the cam rotating at engine speed. The transient fuel pressure in the unit injector was indirectly measured by using strain gauges placed in different locations on the drive train, between the cam and plunger. The experiments were conducted at different rack positions and speeds, variable inlet fuel pressures, variable injector opening pressures, with and without the injector spring and check valve, and with different tip conditions. The events which take place during the injection process were analyzed. A preliminary mathematical model was developed for simulating the plunger and needle system of the General Motors unit injector. Fairly good agreement between the results of the computer simulation and the experimental results was achieved. It is concluded that the fuel pressure acting on the plunger can be indirectly obtained by using strain gauges which measure the elastic deformation in the different components of the drive train between the cam and plunger. The best location for

## HS-018 515

mounting the strain gauges was found to be on the rocker arm. Although it is extremely difficult to measure the needle lift in an actual engine configuration, the point of injection can be well defined from the strain gauge output. The increase in speed, at any rack setting, results in less fuel delivery per plunger stroke. The presence or absence of the check valve appears to have no effect on the pressure trace and the injection process. The condition of the spray tip, whether plugged or blown off, and the injector opening pressure can be detected from the strain gauge output.

by N. A. Henein; T. Singh; J. Rozanski  
Wayne State Univ.

Rept. No. SAE-750773 ; 1975 ; 12p 3refs

Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975. Performed under a contract awarded by the Army Tank-Automotive Command (TACOM), Warren, Mich. Prepared in cooperation with Detroit Diesel Allison Div. and Philip Husak, Wayne State Univ.

Availability: SAE

## HS-018 515

### A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS

Experimental work was conducted with the FIAT 8210 engine to investigate the possibility of reducing the nitrogen oxide and hydrocarbon emissions to meet the 1975 and 1977 California State limits while maintaining the same level of performance and smoke as that of the basic engine. The 8210 engine is a standard production use engine used in European heavy duty trucks. The effects of the following variables were studied: injection timing; injection rate; exhaust gas treatment in the catalytic exhaust system; intake air pressure, including supercharging; and charge dilution with exhaust gas recirculation. These factors were studied both individually and in combination. To obtain the optimum results with a system providing a very fast injection rate, the effect of changes in the degree of turbulence was evaluated. The results of the study demonstrated that the use of the new diesel injection pump, which is able to provide very high injection rates, enable an engine to operate with low values of nitrogen oxide and hydrocarbons with only marginal losses in power and fuel consumption and no change in the smoke level. The use of a catalytic reactor was found to effectively reduce the hydrocarbon emission level, but did little to resolve the combined problem of nitrogen oxide and hydrocarbons. The reduction of the combined nitrogen oxide and hydrocarbons can be achieved by altering the degree of injection advance or by exhaust gas recirculation, but these options adversely affect smoke and performance levels. The use of the Fiat DRF pump provided very rapid injection and achieves results equal to those obtained on a supercharged engine, without the disadvantages of extra complication and increased cost associated with supercharging.

by V. Montanari; A. Antonucci; P. F. Rivolo; C. Lombardi  
Fiat S.p.A.

Rept. No. SAE-750774 ; 1975 ; 21p 10refs

Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

## HS-018 516

### DESIGN CONCEPTS OF THE 400 SERIES

The main design concepts of providing operation while maintaining component and system compatibility. The 400 series consists of a family of single and dual engine open bowl and elevating scrapers, designed to provide performance versatility to handle most types of projects. The series consists of: a single engine scraper, intended for use where traction and flotation requirements are severe, hauling conditions are good, haulage distances are relatively long, and push tractors can be effectively and economically justified; a dual engine open bowl scraper for use when traction and flotation conditions are adverse and hauling conditions are adverse due to steep grades, increased rolling resistance; a push-pull unit, the dual engine scraper, which consists of an attachment to the basic tractor of a cushioned push block and air actuated baling device; the front of the tractor and a rigid push block mounted on the rear of the scraper; and single and dual engine elevating scrapers which are self-loading machines for grading or finishing work and for stripping or placing material. The entire line of scrapers was designed with common features as a dominant feature, providing for simplified parts interchangeability which results in less capital expenditure and storage of spare parts. The commonality also results in standardization of service, maintenance, and operating procedures and training of personnel involved in these functions. The cooling, frame and fifth wheel, hydraulic components, and sheet metal units are identical for all models. Even the air and hydraulic system piping units contain a large amount of commonality. The differences that are necessary to accommodate the basic variations between the bowl, elevating, single, and dual engine vehicles, however, use the same engine.

by R. A. Wade

International Harvester Co., Pay Line Div.

Rept. No. SAE-750779 ; 1975 ; 15p

Presented at the SAE Off-Highway Vehicle Meeting, Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

## HS-018 518

### PREDICTION OF RADIATIVE HEAT FLUX FROM A DIESEL ENGINE

A prediction procedure has been developed for the prediction of the luminous radiative heat flux from the flame to the walls of the engine combustion chamber. It is suggested that the effective excess air ratio which controls the luminous radiation and which is strongly related to the fuel/air ratio. When the overall excess air ratio is larger than unity, the luminous flame is considered to be formed over a time interval at the effective excess air ratio and to have a constant temperature. By regarding the unsteady-state diesel engine as quasi-steady, the results obtained from experiments on the steady confined flame were supplied and a simple prediction procedure was developed. The calculation is easily carried out by using air temperature, excess air ratio, and a simple model for temperature. Good agreements were obtained between the calculated results and previous experimental results. It was found that

flame of the heavier fuel is regularly formed at the larger effective air excess ratio.

by Takeshi Kunitomo; Kazuo Matsuoka; Tatsu Oguri  
Kyoto Univ., Dept. of Mechanical Engineering, Japan;  
Yokohama National Univ., Dept. of Mechanical Engineering,  
Japan

Rept. No. SAE-750786 ; 1975 ; 12p 16refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 519

#### EFFICIENT AND CLEAN DIESEL COMBUSTION

A simple theoretical model is used to attempt to correlate the squared temperature profile of a diesel engine cycle over time, integrated above the level of a significant threshold temperature, with the formation of nitrogen oxides. The resultant ratings permit the evaluation of cycle parameters such as compression ratio, ignition timing, and heat and heat release, with respect to their effects on the compromise between acceptable emission and cycle efficiency. The underlying working theories used in this model compare and complement existing analytical models of diesel ignition, combustion, and soot emission. Theoretically, an advantageous effect on nitrogen oxides formation results from lengthening the injection rate, provided that the latter is not disturbed either by chemical reactions involved with incomplete combustion or by unfavorable fuel distribution regarding temperature areas, wall impingement, or oxygen starvation. The chemistry of combustion, and with it the rates of heat release resulting from the same rate of injection, are influenced in several directions by a change in compression ratio. Basically, the theoretical cycle efficiency increases with compression ratio, but friction losses and heat losses also increase. The present development of open chambers tends towards higher compression ratios, because they provide a longer effective expansion rate with later ignition. Other benefits of high compression ratios are found in starting, reduced hydrocarbons, and reduced white smoke during warm-up or cold idle. Recommendations are included for future experiments and the refinement of theoretical models.

by S. J. Pachernegg

AVL, Austria

Rept. No. SAE-750787 ; 1975 ; 17p 40refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 520

#### EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT

Emissions data were obtained on a variety of farm, construction, and industrial engines to aid in estimation of emissions factors and national impact. Dynamometer emissions tests were made on four gasoline engines and eight diesel engines typical of those used in farm, construction, and industrial equipment. Gaseous and particulate emissions were measured during engine operation on well-accepted steady-state procedures, and diesel smoke was measured during both steady-state conditions and the Federal smoke test cycle. Emissions measured were hydrocarbons, carbon monoxide, carbon dioxide, oxides of nitrogen, oxygen, aliphatic al-

dehydes, light hydrocarbons, particulates, and smoke. Emission of sulfur oxides was estimated on the basis of fuel consumed, and both evaporative and blowby hydrocarbons were estimated where applicable. Photographs of laboratory instrumentation are included. Emissions data were compared with those available in the literature. Other data on equipment size, usage, and population were used with the emissions data to estimate national emissions impact. Emission factors and impact estimates were made separately for each application category (farm, construction, industrial), resulting in the conclusion that these application categories contribute a small, but significant, portion of national pollutant totals.

by Charles T. Hare; Karl J. Springer; Thomas A. Huls  
Southwest Res. Inst.; Environmental Protection Agency  
Contract EHS-70-108

Rept. No. SAE-750788 ; 1975 ; 45p 40refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 521

#### FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS

New formulations of oils have been developed which are resistant to the particularly severe conditions in four stroke motorcycle engines. New bench test procedures have been developed from the field, racing surveys, and road tests. These test procedures have been used for the study of the following variables: oil film and oil consumption (viscosity), piston failure (scuffing and preignition), oil oxidation (thickening), piston cleanliness (dispersancy or detergency), and low temperature starting properties. The test procedure selected for classifying the oils in order of field severity involves six eight-hour cycles, with each cycle consisting of 7 hours at 8,000 revolutions per minute (rpm) at road load and 1 hour with the engine stopped. This test simulates about 4,000 kilometers of travel. The following conclusions regarding the lubrication of motorcycles with air-cooled, four stroke engines of high speed and high output were reached as a result of experiments utilizing the above test procedure: oils lying in the 10 W viscosity range are not satisfactory for the hard driving which is more common in Europe than in the United States or in Japan; preignition can be very severe; oil oxidation is very high; racing experience and bench tests are necessary to adequately test new lubricating oils; engine startability varies as the zero degree F viscosity; 20 W viscosity is adequate to obtain good starting; and fully synthetic oil is not an economical solution for best results.

by M. J. DeJev; B. Brandone

Compagnie Francaise de Raffinage, France

Rept. No. SAE-750789 ; 1975 ; 13p  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 522

#### MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION

An engine lubricant has been developed for diesel and gasoline engines which covers all the service and climatic conditions prevailing in Central European countries. A comprehensive market survey indicated that an SAE 20W-40 multigrade oil

## HS-018 523

with a viscosity of 4,800 cP at zero degrees F would be suitable for use all the year round in commercial vehicles in mixed fleets. Bench tests conducted on European test engines, performance tests on other equipment, cold start tests with fresh and used oil, and tests at the manufacturers were used to evaluate the performance of the lubricant in gear boxes, hydraulic systems, and other off-highway and construction equipment. The new multi-purpose lubricant was introduced to the European market in September 1974, and is now used in more than 25,000 vehicles. The new lubricant is used in such mixed fleets as public transportation systems, construction company fleets, and municipal service departments, sometimes replacing up to ten different grades of lubricants previously used. Investigation of a great number of used oil samples from a variety of vehicles and equipment operating under widely differing conditions during the first year of use of this lubricant indicated that the oil change periods in most of the engines evaluated could be reasonably increased. Reduced oil consumption on the order of 10% to 25% was noted in many applications, the exact reduction being dependent on the type of lubricant previously used. The use of this lubricant in rotary piston engines and two-stroke gasoline engines is not recommended. Laboratory and field test data demonstrate stay-in-grade characteristics, excellent wear protection, and engine cleanliness with this lubricant. It is concluded that there is hardly an instance where this multigrade lubricant is not competitive with any monograde lubricant.

by G. C. Fleischhack  
Deutsche BP Aktiengesellschaft  
Rept. No. SAE-750790 ; 1975 ; 10p 7refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

## HS-018 523

### EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES

In 1973 a modified SAE 10W-30 multigrade heavy duty engine oil designated OMD-75 was introduced into a wide variety of British Army equipment in place of the single SAE 10 and 30 grades previously used. Generally the introduction of the multigrade engine oil into a wide variety of different equipments has been successful. However, some problems with the use of a multigrade engine oil in certain diesel air-cooled engines have been encountered probably associated with high base stock volatility. A number of other problems are also described and examples given where multigrade engine oils have caused difficulties. OMD-75 has been successfully used in Allison transmission systems. The use of the "FZG" gear machine as a method of test for the shear stability of viscosity index improvers is described and results presented for a number of different types of polymers. The machine was found to be more severe than a diesel-injector rig and no correlation seems to exist between the two methods of test. After two years' experience with the use of OMD-75 in most British ground service equipment, commercial vehicle fleets and various engineering equipments, it is concluded that this lubricant

can satisfactorily lubricate the majority of engine systems over the temperature ranges from -20 C to 40 C.

by P. R. Morris  
Ministry of Defence, United Kingdom  
Rept. No. SAE-750791 ; 1975 ; 10p 7refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

## HS-018 524

### EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP

The use of radial piston pumps as sources of power to operate either open or closed center systems using either open or closed loops is discussed. The pump can be operated with controls which modulate pressure or flow or both, automatically, in response to load magnitude, speed, position, or temperature or in response to operator input and using a mechanical, electrical, hydraulic, sound, or light signal. Schematics of various hydraulic systems and pumps are provided.

by James M. Bahl; Arvid Waschek  
Deere and Co.; John Deere Waterloo Tractor Works  
Rept. No. SAE-750805 ; 1975 ; 7p 2refs  
Presented at the SAE Off-Highway Meeting, Milwaukee,  
Wisc., 8-11 Sep 1975.  
Availability: SAE

## HS-018 525

### LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW APPROACH

Previous developments in steering systems are outlined and the design concepts required to adapt the steering function to load sensitive variable flow-pressure circuitry are highlighted. Since the steering function power demands are normally low for corrective maneuvers, it is ideally suited to the environment of a central load-sensitive system. The general concept of a load-sensing steering valve and its relative design role to the other system components is developed, emphasizing standard meter-in load-sensing technology. The possible new feathered and absolute type systems are introduced. Schematics are provided from which specific construction features of the circuit load-sensitive components may be improvised.

by J. L. Rau  
Rept. No. SAE-750806 ; 1975 ; 8p 3refs  
Presented at the SAE Off-Highway Meeting, Milwaukee,  
Wisc., 8-11 Sep 1975.  
Availability: SAE

## HS-018 526

### CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION

The possible causes of hydraulic power losses in both closed and open loop hydraulic systems are discussed. The means of minimizing these losses with the proper choice of closed versus open loop systems and with maximum utilization of variable displacement pump controllability are considered. Also discussed are means of reducing prime mover size with pump

ver limiting controls to increase power generation efficiency. Examples are analyzed to illustrate the energy saving potential of closed loop pressure control, open loop pressure flow compensation, and closed or open loop pump power savers. Schematics and photographs of closed loop systems provided.

Allen Myers  
Idstrand Corp., Sundstrand Hydro-Transmission Div.  
pt. No. SAE-750807 ; 1975 ; 23p  
sented at the SAE Off-Highway Vehicle Meeting,  
waukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

-018 527

### FFECT OF FLUID TEMPERATURE ON THE RFORMANCE OF FRICTION MATERIAL

Effect of fluid temperature on the performance of a wet friction couple is examined and how such an effect can be modified by friction material and oil type selection, and conditions of use is shown. Machine testing of three friction materials (low, moderate, and high density graphitic paper) in three (a heavy duty engine oil, Dexron, and a multipurpose gear lubricant) controlled at varying temperature levels was conducted. Modifications of temperature effects by pressure and other loadings are also demonstrated. In addition, study of friction hysteresis with temperature-performance at temperatures as affected by previous history is included. Theories are proposed to explain certain trends noted in the data. While these are intended to aid in optimizing design for specific tests, further study to improve understanding in this area is needed.

Robert L. Fish; Frederick A. Lloyd  
 asbestos-Manhattan, Inc., Stratford Div.  
pt. No. SAE-750809 ; 1975 ; 11p  
sented at the SAE Off-Highway Vehicle Meeting,  
waukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

-018 528

### IE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES

The evolution of the modern elastomeric radial lip seal parallels the evolution of the automobile. Higher operating temperatures in modern automotive applications are approaching the limits of modern seal designs and materials. At elevated temperatures, seals may become hard and brittle, blister, crack, and degrade. Methods of upgrading seal materials and reducing temperature through seal design are discussed. New materials (such as phosphonitrilic fluoroelastomer) and seal designs such as tetrafluoroethylene may offer relief from high temperature problems.

L. A. Horve  
icago Rawhide Mfg. Co.  
pt. No. SAE-750810 ; 1975 ; 10p 5refs  
sented at the SAE Off-Highway Vehicle Meeting,  
waukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

HS-018 529

### WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)

The benefits obtained from utilizing electronic monitoring equipment now available in the agricultural field are described. Particular emphasis is placed on planting and harvesting operations. The equipment (sensors, transmission, and displays) and the benefits (efficiency of operation, protection of equipment, physical safety, increased food production and quality, conservation of resources, mental and physical relief to operator, and application of research and development technical data to machine operation) of monitoring are discussed. Decision-making utilizing monitoring can help solve the many problems in agriculture.

by Ronald W. Steffen; James H. Anson  
Dickey-john Corp.  
Rept. No. SAE-750812 ; 1975 ; 10p 25refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

HS-018 530

### THE NATURE OF ABRASIVE WEAR

There are many devices for measuring the response of materials to abrasive wear. Measurements do not consistently agree because of variable differences. Classification areas that help define the variables are an aid to the selection and application of laboratory and service tests. To three previously proposed categories, four others are now added for completeness and in hopes that misapplication of the terminology will be minimized. These are described and linked to previously conducted laboratory tests. Of the categories, clean fluid erosion, impingement erosion, erosion or parallel-flow low-stress abrasion, gouging-abrasion and erosion-corrosion, most attention is given to parallel-flow erosion because it seems most pertinent to the abrasion problems of automotive engineers and the focus of present rubber-wheel erosion tests. Common abrasive and rock forming minerals are listed and photographs are provided. Variables to be identified and described when reporting abrasion tests are suggested: the velocity of impingement or abrasive motion; the angle of attack; information about the probable stress developed at the wearing surface; the nature of the abrasive; the presence of any corrosion factor that can be recognized; an approximation of the relative proportions of cutting-wear and deformation-wear, if they can be recognized; and the physical details of the abrasive environment.

by Howard S. Avery  
Abex Corp.  
Rept. No. SAE-750822 ; 1975 ; 17p 21refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

HS-018 531

### VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS

A five-vehicle, 64,000-kilometer test with 7.45 liter V-8 engines was conducted to determine if synthetic engine oils provided performance sufficiently superior to that of conventional en-

gine oils to permit longer oil change intervals. The results show better performance in two areas of deposit control; inferior performance with respect to wear protection; and essentially equivalent performance in the areas of fuel and oil economies. Based on these data, it was concluded that synthetic engine oils do not provide the necessary performance required to safely recommend their use for extended oil change intervals. In addition, a cost analysis shows that the use of synthetic engine oils, even at a change interval of 32,000 kilometers, will essentially double the customers' cost compared with conventional engine oils at the 12,000-kilometer change interval. Photographs of component wear and deposits are provided.

by John J. Rodgers; Richard H. Kabel  
General Motors Corp., Res. Labs.  
Rept. No. SAE-750827 ; 1975 ; 11p 9refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

### APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

The significant performance areas of new United States Army arctic engine oils in military hydraulic and power transmission fluid (HPTF) systems are emphasized. The new oils function well as year-round lubricants in Army HPTF systems including: automatic and power-shift transmissions, power steering units, hydraulic winches, pumps, and mechanical and construction equipment hydraulic systems. Previously conducted field testing with a wide range of Army vehicles, and laboratory tests of anti-foaming, wear, compatibility, viscosity, and outside-arctic applications are discussed. It appears that the new synthetic arctic engine oils have significant potential military applications in HPTF systems outside arctic regions as well as inside. Problem areas are discussed and a recommendation is advanced for the development of a truly universal HPTF.

by P. D. Hopler; S. J. Lestz  
Army Mobility Equipment Res. and Devel. Center; Army Fuels and Lubricants Res. Lab.  
Rept. No. SAE-750828 ; 1975 ; 14p 4refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

### LUBE OIL FILTER EVALUATION

A new and meaningful test method for evaluating the performance of lubricating oil filters has been developed. The test procedure is based on the multi-pass method previously formulated for hydraulic fluid power filters, which since has been accepted on both national and international levels. The multi-pass procedure assesses only the particle separation characteristics of a filter and isolates all other factors which could influence the results. The development effort which resulted in this new lube oil filter test method required an international opinion survey, industrial advisory meetings, and an extensive testing program. A total of 25 different filter elements representing 13 various manufacturers have been evaluated

with the multi-pass procedure. Details of the method are along with repeatability and discriminatory test results.

by L. E. Bensch  
Oklahoma State Univ., Fluid Power Res. Center  
Rept. No. SAE-750845 ; 1975 ; 12p 4refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

### THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE

An analytical expression is developed which describes the influence of leakage flow on the separation performance of a filter element in a hydraulic system. Actual data associated with the flow-pressure drop characteristics of both commercially available filter elements and by-pass valves are used to illustrate the leakage flow relative to such valves. Graphs and illustrations demonstrate the performance deterioration due to by-pass valve leakage. It is shown that the separation performance of a filter element used in a hydraulic system to protect critical components can be seriously degraded by permitting fluid to by-pass the filter element.

by R. K. Tessman  
Oklahoma State Univ., Fluid Power Res. Center  
Rept. No. SAE-750846 ; 1975 ; 7p 4refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

### FILTER SELECTION BASED ON COMPONENT SENSITIVITY ANALYSIS

The development of the International Standards Organization's Multi-Pass Test for Filters and the National Fluid Power Association's Contaminant Sensitivity Test for Components led to the evolution of a new method for selecting a filter to protect a given pump. This method considers the severity of the application, the sensitivity of the components, and the particle capture capability of the filter. Filter selection charts have been developed which illustrate the influence of operating pressure, the pump contaminant tolerance, the expected contaminant ingestion, and the desired service life on the selection process. Emphasis is placed on user-oriented information and on the type of charts which component manufacturers could supply the user as well as the type of charts a filter manufacturer could supply. Illustrations of these selection charts are presented.

by E. C. Fitch  
Oklahoma State Univ., Fluid Power Res. Center  
Rept. No. SAE-750847 ; 1975 ; 9p 5refs  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wisc., 8-11 Sep 1975.  
Availability: SAE

IS-018 536

## FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES

A research program to investigate the fundamental nature of nitric oxide (NO) formation was conducted as part of a developmental program aimed at reducing emission levels in the exhaust of diesel engines. A rapid acting sampling valve to obtain gas samples directly from the combustion chamber of a running diesel engine was developed concurrently with a mathematical model for the formation of NO in diesel engines. Gas samples were obtained from the following types of diesel engines: a single spray sector of a large quiescent direct injection combustion chamber; a deep bowl direct injection combustion chamber using inlet induced swirl; and a Ricardo Comet V indirect injection combustion system. The temporal and spatial distribution of NO and the local air fuel ratio were determined in each case. The model depended heavily on the information provided by the gas samples which, in conjunction with high speed photography of the combustion process, indicated that NO was formed only in gasses exposed to high temperature flame and that any NO found in cooler areas of fresh air or weaker mixture appeared there solely by mixing with the hot gasses, despite the high oxygen concentration. In addition, the delay between combustion and the appearance of NO is clearly shown, and this allowed considerable simplification of the model in that only the reactions involved in NO formation needed to be considered kinetically in order to give good correlation between experimental and theoretically predicted exhaust NO content over most of the engine operating range. It is concluded that the gas sampling valve proved to be a valuable tool in understanding the fundamentals of NO formation in particular and combustion problems in general and that it greatly assisted in the formulation of a mathematical model for prediction of NO emissions from diesel engines. The model used published values for the chemical reaction rate and equilibrium constants and was found to give good correlations with experimental emissions for engine variables such as speed, engine load, and injection retard.

by David R. Nightingale  
 Ricardo and Co. Engineers (1927) Ltd.  
 Rept. No. SAE-750848 ; 1975 ; 19p 20refs  
 Presented at the SAE Off-Highway Vehicle Meeting,  
 Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

IS-018 537

## NON-WEARING FERROFLUIDIC SEALS

A ferrofluidic seal constitutes a means of generating a series of high intensity magnetic fields which entrap magnetic liquid as a dynamic sealant. This usually consists essentially of magnetic pole blocks and a permanent ring magnet. When the magnetic field is 'painted' onto rings that are machined either into the shaft or the pole blocks, magnetic fields focus and hold the liquid between the surfaces of the rotating and stationary rings. The fluid completely and hermetically fills the gap between the surfaces as if it were a liquid O-ring or liquid lip seal. The pressure that the seal can withstand depends on the number of these O-rings, each ring typically withstanding a differential of 3 to 5 pounds per square inch. These seals are now widely used in vacuum and nuclear systems for rotary shaft penetrations and in gas pressure systems. Leakage rate is unmeasurably low as measured on a mass spectrometer. The

liquid seal is generally forgiving of surface finish, mechanical run-out, and eccentricity. Fluids of many different physico-chemical families have been developed for operating under widely differing conditions, including diesters for vacuum and wide temperature range; fluorochemicals for highly reactive environments such as chlorine, ozone, sulfur dioxide, and acidic vapors; and polyphenylethers for ultra-hard vacuum and maximum radiation resistance. These ferrofluidic seals have also found wide application as exclusion seals preventing liquid, vapor, metallic, and non-metallic contaminants from reaching machinery parts in applications such as digital disc drives, grinding spindles, and textile wind-up heads. New engineering developments now also make these seals applicable on oil systems for gear boxes, transmissions, drives, and other sealed lubrication systems where they totally contain the oil while excluding external contaminants. It is concluded that these ferrofluidic seals offer the designer a uniquely different, non-wearing, zero-leakage alternative to conventional rotary seals. Further work with the seals is expected to result in performance benefits in conventional packing, face, and lip seals.

by Ronald Moskowitz; Frederick D. Ezekiel  
 Rept. No. SAE-750851 ; 1975 ; 12p

Presented at the SAE Off-Highway Vehicle Meeting,  
 Milwaukee, Wisc., 8-11 Sep 1975.

Availability: SAE

HS-018 538

## WHAT'S NEW WITH SEALS?

Mechanical configurational aspects, material developments, exclusion devices, standardization of testing, and national and international standardization and metrication of sealing devices, particularly reciprocating dynamic sealing devices, are described. Every seal design is a compromise between the high friction, high wear, and excellent sealability of a pure compression seal to the low friction, low wear, and poor sealability of a pure lip-deflection type of seal. State-of-the-art seal designs are tending toward the pure interference type with high sealability. The development and utilization of new materials has reduced the high friction, frictional heat, and wear, making these designs feasible. Some of the older polymers have been significantly improved and new thermoset and thermoplastic varieties of polymers have been developed and have enjoyed substantial success. Emphasis has been placed on the development of superior exclusion devices, and a number of new improved packings have permitted operation at higher pressures and broader temperature ranges than was previously possible. The industry is currently in the process of attempting to set up a standardized testing system for packings such that the basic performance characteristics of various seals can be evaluated by the manufacturer. This will also make it possible for the user to evaluate performance characteristics of seals supplied by different manufacturers using the same set of standards. The National Fluid Power Association is an industry group involved in developing national standards for sealing devices and test procedures. This group is currently working on the development of a uniform test method for evaluating and comparing packing performance. The Basic Fluid Power Research Program at Oklahoma State University is currently developing and authenticating performance standards for fluid power equipment, including seal performances. There is also an increasing emphasis on an international approach to standardization, with the Technical Committee of

the International Standards Organization having responsibility for standards for sealing devices.

by John G. Stone; John B. Scannell  
Parker-Hannifin Corp., Parker Seal Group  
Rept. No. SAE-750852 ; 1975 ; 12p  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wis., 8-11 Sep 1975.  
Availability: SAE

HS-018 539

### AN INVESTIGATION INTO PISTON RING SCUFFING DURING RUNNING-IN

The influence of lubricants, materials, and surface finish on scuffing failure was investigated using a special test rig and a high speed, single cylinder engine. The rig, which was used to gain closer control and ease of observation, reproduces characteristic piston ring and cylinder bore scuffing and has defined a range of performance in terms of contact load, ring velocity, and liner temperature. During each test, signals of test load, ring/liner friction force, and crank angle are monitored and displayed continuously on an oscilloscope screen. The friction force signal provides a useful means for detecting the occurrence of scuffing. The test unit comprises a 700 cubic centimeter single cylinder high speed spark-ignition engine. Metallurgical examination of the rings and liners failed in the rig has shown that the surface deterioration exhibits all the features of scuffing encountered in service. Under "constant-load" conditions, scuffing has been shown to be sensitive to the combined influence of crank-speed, maximum pulse load, liner temperature, and lubricant temperature. For given temperature conditions, scuffing appears to be related to a critical condition resulting from the combined effect of contact load and ring velocity, which becomes a maximum at some point between top dead center and mid-stroke. It has also been demonstrated that the static load component, which essentially represents the elastic ring force of a conventional ring/bore configuration, can influence the position of initial failure. Some lubricant additives were found to significantly improve the performance of a base oil with intermediate performance for bore finishes, higher viscosity, and ring materials. Trends in performance were found to correlate with service experience and a "performance-factor" has been derived relating median failure loads for various speeds. Confirmation of rig results is being obtained in the engine in terms of operating conditions of ring velocity and ring contact load defined by the "performance-factor".

by J. E. Willn; P. S. Brett  
British Technical Council of the Motor and Petroleum  
Industries  
Rept. No. SAE-750861 ; 1975 ; 12p 7refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975. First presented at the Institution  
Conference on Piston Ring Scuffing, 13-14 May, 1975 and re-  
presented by permission of the Institution of Mechanical  
Engineers.  
Availability: SAE

HS-018 540

### HYDRAULIC RESERVOIR BREATHERS. HOW GOOD

The U.S. Army Mobility Equipment Command is responsible for specification requirements for a variety of construction

equipment. In studying a newly acquired warehouse truck, it was noted that the hydraulic fluid was quite even though the system filter was not an exceptionally good one. The vehicle manufacturer stated that study had indicated that the air breather on the reservoir was a major potential point for contamination and that the vehicle had been equipped with a much more efficient breather required by the Government specification. As no recommended breather test standard appeared to exist, a test was developed to simulate the oil volume change normally found in hydraulic forklifts. The test procedure involves cleaning up the reservoir, stalling the test breathers, adding dirt periodically, and adding oil until the terminal pressure drop is reached. A flow counter plumbed into the system was used to determine dirt ingestion through the filter and into the oil. Elements tested included sintered bronze, phenolic ribbon, and pleated paper elements. The major conclusion reached was that the pleated oil filter element makes the best and least expensive reservoir breather. The test showed dramatic differences in efficiency and dirt capacity of the breathers tested, the pleated filters element having more than 10 times the capacity of the traditional ribbon breathers. It is recommended that industry investigate breather testing and adopt a suitable test that can effectively rate the elements.

by John M. Karhnak, Jr.; Hermann Spelten  
Army Mobility Equipment Command; Federal Republic of  
Germany Armed Forces  
Rept. No. SAE-750853 ; 1975 ; 11p 1ref  
Presented at the SAE Off-Highway Vehicle Meeting,  
Milwaukee, Wis., 8-11 Sep 1975.  
Availability: SAE

HS-018 541

### PAVEMENT FRICTION TEST TIRE CORRELATION FINAL REPORT

A correlation program was conducted in which skid resistance of four typical pavements was measured with the friction test tire (ASTM E 249) and with a somewhat larger tire (ASTM E 501). The correlation program involved a large scale field test program which was supported by laboratory tests on a high speed facility. The five factors used as variables in the test program included pavements selected to span a range of skid resistance; tire type; speeds of 20, 40, and 60 mph; water depths of 0.033 inches; tires in the two extreme conditions of being shaved to below the wear line; and morning and afternoon tests to evaluate the effects of pavement, tire, and ambient temperatures. Although the relative rates of wear of the two tires have not been established, they do not differ appreciably in their performance as pavement test tires. Tire E 501 gives readings about 4% higher than tire E 249 under standard conditions. This difference is of the same order of magnitude as the error in skid testing, indicating that reversals are expected, with tire E 249 occasionally giving higher readings than tire E 501. Generally, the effect of test variables is found to be the same for both tires. However, there is evidence that tire E 501 is less sensitive than tire E 249 to variations in normal load, but has greater sensitivity to the effect of tire wear. Under dry conditions, the difference between the two tires is somewhat greater, with tire E 501 giving a reading 5 to 10% higher than tire E 249. Based on these findings, it is concluded that tire E 501 can replace tire E 249 in the friction test.

using the same test conditions as those previously used. Skid resistance requirements should be increased by about 4%.

by R. R. Hegmon; S. Weiner; L. J. Runt  
 Federal Hwy. Administration, Offices of Res. and Devel.,  
 Washington, D.C. 20590  
 Rept. No. FHWA-RD-75-88 ; 1975 ; 181p 20refs  
 Prepared in cooperation with the Texas Transportation Inst.  
 and Calspan Corp.  
 Availability: NTIS

HS-018 542

### SAFETY OF CATALYTIC CONVERTER QUESTIONED

The safety aspects of the new catalytic exhaust converters are considered. Many cases of evidence that a converter can start fires in dry vegetative matter when the vegetation is in direct contact with the converter are related. Converters can heat up to around 800 F, hot enough to ignite not only grass and brush but also paper, kerosene, and motor soil. Added to the controversy over the sulfuric acid mist emitted from catalytic converters, this fire danger emphasizes the need for the development of alternative means for reducing exhaust emissions. Some of these alternatives (new types of engines, better fuels and fuel/air mixing) are mentioned and continued development is urged.

by William L. Roper  
 Publ: California Highway Patrolman v39 n10 p6-7, 38-9, 42-3,  
 90-1 (Dec 1975)  
 1975

Availability: See publication

HS-018 543

### THE PREVENTION OF DANGEROUS BEHAVIOUR. 1. PREVENTION BY SELECTION: AN UNSUCCESSFUL APPROACH

Although many people assume that dangerous or risky driving behavior which results in accidents could be avoided if everyone made the effort, such a belief is erroneous. One approach to the prevention of dangerous driving behavior is the selection model, in which anyone who does not conform to the rules must be eliminated from the traffic community. This model assumes that the elimination of these accident prone drivers will automatically lead to safe traffic. Problems with this approach include the difficulty involved in deriving stringent arguments from the very low correlations that have been established between such criteria as driving behavior, personality traits, or health on the one hand and accident rate on the other. In addition, translation of a statement such as "5% of the automobile drivers are responsible for 40% of the fatal accidents" into absolute numbers indicates that large numbers of drivers would have to be eliminated in order to prevent a few accidents. Errors of perception, decision, and action which may result in dangerous driving behavior frequently result from the limited capacity for processing information supplied to the sensory system. Psychological and psychophysiological experiments have provided a number of insights into the mechanism of attention which are of major importance to the prevention of dangerous behavior. Both over-arousal and under-arousal will lead to decrements in driving performance. The state of extreme drowsiness known as 'highway hypnosis' may result from highly predictable traffic

behavior and visual stimulation. Measures which may be instituted to aid the driver with the choice and processing of relevant aspects of the traffic situation include: directional signs; demarcation, distance, and velocity indicators; differentiated tail lights; road design; and traffic legislation. This approach to the prevention of dangerous driving behavior has yielded better results than other approaches so far.

by John A. Michon  
 Publ: Arts en Auto v40 n19 1571-4 (Oct 1974)  
 1974 ; 7refs  
 Availability: See publication

HS-018 544

### PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

Two analyses of the relationship between seat belt usage and injuries in automobile accidents were conducted by the Institute for Road Safety Research SWOV, of the Netherlands, using data from 22,000 drivers and their vehicles involved in accidents. The first analysis was based on data from about 8,000 drivers of cars involved in accidents on divided roads and investigated the influence of the use and non-use of seat belts on the type and severity of injuries to the driver. The major conclusion from this study was that the lap belt, 3-point belt, and diagonal belt all have a very similar influence on injuries and injury severity when compared to the group of non-users. The average effectiveness of seat belts was found to be very good, preventing fatal injuries at least 60% of the time and resulting in a 30% decrease in the number of severe injuries. There is a pronounced absence of skull and brain injuries among seat belt users. The second analysis investigated the associations between the three types of seat belts individually and the separate injuries and injury severities using data on about 1,300 drivers that were using a certain, known type of seat belt. On the whole, the differences were found to be connected to less severe injuries. The lap belt appears to be associated with abrasions, lacerations, and contusions of the face and neck. The 3-point belt was found to be more associated with the absence of skull injuries, right arm injuries, and injury severity class 0/no injury'. The diagonal belt is associated with abrasions, lacerations, and contusions of the left arm and the left leg, as well as moderate spinal column lesions and rib and sternum contusions. It is concluded that the users of lap belts and users of 3-point belt systems enjoy a comparable and considerable reduction of injury severity in accidents. The users of diagonal belts, while better protected than non-users, have less protection than the users of either of the other types.

by A. Edelman; L. T. B. Van Kampen  
 Publ: Arts en Auto v40 n19 p1556-9 (Oct 1974)  
 1974 ; 7refs  
 Availability: See publication

HS-018 545

### TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES

In operating conditions, engine oil viscosity undergoes temporary changes due to the effect of three physical parameters: temperature, shear stress, and pressure. The temporary

viscosity loss of engine oils was investigated and the temporary viscosity changes on multigrade engine oils at the crankshaft bearings of European gasoline engines was evaluated. Oil temperature was measured and a calculation was made of the distribution of shear rates and pressures acting on the lubricant film at the central crankshaft bearing of a European engine. An experimental evaluation was then made of the temporary viscosity changes at high temperature of a multigrade oil under the separate action of high shear rates and pressures. A rolling-ball viscometer was used to measure the temporary viscosity of oil under pressure. Finally, an attempt was made to draw up a balance of the temporary viscosity of a multigrade oil in the different points of the bearing under examination. While the experimental work demonstrated the importance of the temporary viscosity changes of lubricants at engine parts, it is concluded that further research must be conducted to investigate the simultaneous effect of shear stresses and pressure on the rheological properties of lubricants.

by G. F. Busetto; G. Capello; U. Giulio; E. Volpi

Fiat, Italy

Rept. No. SAE-750862 ; 1975 ; 17p 22refs

Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.

Availability: SAE

#### INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974

Discussions by over 100 researchers from academic institutions and industrial research organizations of the following vehicle dynamic problems are presented: the stability of taxiing aircraft; dynamic analysis of a pendulous suspension system; a track model for computer studies of railway vehicle dynamics; oscillatory instability of a tractor-semitrailer vehicle; the stability parameters of an articulated vehicle in five degrees of freedom; direct and indirect methods for stability studies of articulated vehicles; scheduling delays in synchronous transportation networks; the application of an electroviscous damper to a vehicle suspension system; simulation of vehicle braking with anti-lock devices; a comparison of tire influence on vehicle handling; driving simulator design for realistic handling; look ahead steering strategy; optimal aero-mechanical design for specialized man-in-the-loop driver-vehicle systems; and techniques for obtaining improvements in the handling qualities and performance of a submerged vehicle. Also discussed are: a finite element analysis of automotive sheet metal under impact loading; a technical and analytical approach to ride quality improvement on a surface effect ship using active feedback control; levered vehicle design by simulation; responses of segmented plate structures to traveling normal loads; practical operation and testing of an urban electric vehicle; and limiting performance characteristics of vehicle impact safety devices. Abstracts of 26 vehicle dynamic research efforts not discussed in any detail are also provided.

by H. K. Sachs, ed.

Virginia Polytechnic Inst. and State Univ. at Blacksburg, Va.; American Society of Mechanical Engineers; Wayne State Univ.

1975 ; 332p refs

Includes HS-018 547--HS-018 560.

Availability: Swets and Zeitlinger, Amsterdam

#### OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY

The stability behavior of heavy duty tractor-semitrailer vehicles was examined using a plane linear vehicle model. The stability behavior of a 45,000 pound vehicle was calculated at 50 and 80 kilometers per hour using the model. The semitrailer was characterized by an exceptionally short wheel base and a relatively high moment of inertia. It was found that under these conditions the vehicle displayed oscillatory motion. An attempt was made to modify the parameters of the semitrailer to improve its stability behavior, but it brought no improvement. The use of a suitable trailed, dependent type steering system did enhance the stability considerably. Diagrams of the vehicle model, equations of motion, and plots of various transient response functions are included.

by E. Bisimis

Technische Universität Braunschweig, Institut für Fahrzeugtechnik

Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p70-83 1975 ; 11refs

Availability: In HS-018 546

#### PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM

A linearized mathematical model was formulated to study the lateral dynamics of a simply articulated vehicle in five degrees of freedom; namely, towing vehicle lateral velocity and turn rate, trailer articulation angle, and roll angles of the towing vehicle and trailer. A computer program was developed, incorporating the model, to study the stability characteristics of a car-trailer combination by determining system eigen-values for varying vehicle configurations. The input data to the computer program include tire characteristics, vehicle geometry, vehicle suspension properties, and vehicle velocity. Normal modes, modal instabilities, the speed root locus, car roll steer, the effect of hitch loading on car roll steer, and trailer roll steer are discussed. It is shown that the roll degrees of freedom are significant in the stability analysis, particularly with regard to the interaction between car roll steer and trailer articulation motion. The addition of two roll degrees of freedom is necessary to adequately determine the stability characteristics of the car-trailer system. This is primarily due to the coupling between the roll and directional degrees of freedom caused by roll steer. As the stiffness of the car's and/or trailer's suspension decreases, the effect of roll steer on stability becomes more significant. The articulated vehicle's weight distribution and suspension properties are highly interactive, and this interaction must be taken into account when investigating the stability of a given car-trailer system.

by Howard T. Moncarz

University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.

Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975, p84-111 1975 ; 7refs

Availability: In HS-018 546

HS-018 549

## DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES

The preliminary investigation of a comparison of the direct method (simulation) and indirect method (eigenvalues) in the stability studies of articulated vehicles is presented. The basic differences between the two methods, where each of these methods is favored and how each of these methods can assist designers to improve the handling and stability of the articulated vehicles are discussed. It is concluded that: the indirect eigenvalue method is more efficient in the preliminary design stage, or planning for major engineering modification; and simulation is best used to study the effect of final design configuration, and the vehicle response under emergency maneuvers.

by J. P. Wong; R. L. Collins  
 University of Louisville, Mechanical Engineering Dept., Louisville, Ky.  
 Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975, p112-7  
 1975 ; 6refs

Availability: In HS-018 546

HS-018 550

## SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS

The performance of synchronous control in network scheduling for automated transportation systems is investigated. The effect of considering multiple paths on delay is studied and compared to the expected delay for systems under quasi-synchronous control. Quantitative results describe the improvement in performance gained by the transynchronous modification (which allows scheduled slot slipping at interchanges) of the synchronous scheduling scheme. The implications of scheduling strategy on queue formation within stations are demonstrated. It is found that synchronous-type control schemes require parallel or lateral berthing in stations whereas, quasi-synchronous control imposes no such restriction on station design. Diagrams of a possible personal rapid transit (PRT) system for Trenton, New Jersey, and a guideway grid concept for a PRT, in addition to a series of delay curves, are included.

by Alain L. Kornhauser; Patrick J. McEvaddy  
 Princeton Univ., Princeton, N. J.  
 Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p122-40  
 1975 ; 14refs

Availability: In HS-018 546

HS-018 551

## THE APPLICATION OF AN ELECTROVISCOSUS DAMPER TO A VEHICLE SUSPENSION SYSTEM

The results of a computer study examining the usefulness of a controllable, variable effect, non-linear damper in a vehicle suspension system are reported. The effect on the performance of a simple model suspension of the addition of a controllable spring/damper link is shown. The damping characteristic of the controllable element is that of a viscous damper with a threshold force required to move it; the viscous force is fixed whereas the threshold force is pre-selected. This is an

idealized form of the characteristic expected from a prototype damper which operates on electroviscous fluid and is controlled by imposing an electric field on the associated electroviscous valve or shear plate. Results indicate that a significant degree of control over the ride characteristics for a wide range of sprung mass may be expected. Diagrams of the electroviscous damper system and various response curves are provided.

by W. A. Bullough; M. B. Foxon  
 The University of Sheffield, Dept. of Mechanical Engineering, S1 3JD, U.K.; Department of the Environment, St. Christopher House, London, SE1 OTE, U.K.  
 Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p144-60  
 1975 ; 8refs

Availability: In HS-018 546

HS-018 552

## SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES

A simulation program, with the aid of which it is possible to calculate the course deviation and braking distance of motor vehicles fitted with anti-skid devices, is described. The basic aspects of the computation program are presented. The best anti-skid system would be two-axle anti-skid devices with "select low" features on the rear axle. The following representations are included: equations of motion (symbolic representation); dead wheel and driving wheel equations of motion; kinematic variables of tires; supposed and real deformation in patch; synthetic tire diagram, slip angle and slip data curves; anti-skid device operation curves; anti-skid device positions of a two-axle vehicle; and the braking process of a vehicle without steering and with steering reaction.

by M. Mitschke  
 Technische Universität, Institut für Fahrzeugtechnik  
 Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p161-75  
 1975 ; 8refs

Availability: In HS-018 546

HS-018 553

## A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING

A preliminary study on the effects of different tire designs (radial, bias-belted, or bias-ply) on vehicle handling and directional stability is presented. The vehicle is represented in simplified form so that the effects of the tires are clearly discernible. Direct digital simulation is used to provide comparative data when considering certain non-linear effects such as tire loading due to roll. The response of the vehicle to various (open loop) maneuvers (the free turn, the driven turn, the braked turn, and the lane change) is investigated. It is indicated that the radial tire tends to produce more sensitive response to input commands than the bias or belted bias tires.

by R. L. Collins; J. P. Wong  
 University of Louisville, Dept. of Mechanical Engineering, Louisville, Ky.  
 Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p176-84  
 1975 ; 7refs

Availability: In HS-018 546

HS-018 554

## DRIVING SIMULATOR DESIGN FOR REALISTIC HANDLING

The steps that should be taken to obtain good handling in a part-task simulator capable of simulating highway driving up to 90 mph under normal maneuvering conditions are outlined. The driver/vehicle interface is discussed in detail. The sub-systems necessary for accurately providing this interface in simulation are described. Diagrams of the simulator system and the simulator itself, and photographs of the motion platform, the investigator's station, and the computer generated visual scene are provided. It is concluded that: there should be no appreciable delay or lag in any sensory feedback channel to the driver/subject, other than those that are due to the vehicle dynamics themselves; at least two motion degrees of freedom and preferably three (roll, yaw, and lateral translation) should be included; the display system must portray the correct geometric relationship of the road to the subject; the display must provide a clear impression of motion; introducing sound and vibration has the advantages of providing better velocity sensing by the subject and masking extraneous noises in the simulator room; and the procedure for program control transfer must be carefully developed.

by Walter W. Wierwille

Virginia Polytechnic Inst. and State Univ., Blacksburg, Va.  
24060Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p186-99  
1975 ; 20refs

Sponsored by the General Motors Corp. and Virginia Polytechnic Inst. and State Univ.

Availability: In HS-018 546

HS-018 555

## LOOK AHEAD STEERING STRATEGY

A steering strategy is described which postulates a servo mechanism or human operator which controls a road vehicle by deflecting the steering linkage proportional to the alignment error between the lane centerline and the vehicle centerline a certain distance ahead of the vehicle center of gravity. A simple analytic expression is derived for the optimum value of this distance for the case of a neutral steering automobile with four identical tires, radius of gyration in yaw equal to half the wheelbase, and no delay between error perception and execution of the steering correction. The look ahead distance is found to vary approximately as the square of the vehicle speed and inversely as the cornering stiffness of the tires. It is found that small variations in the strategy are required to account for delay in deflecting the steering linkage and for substantial variations in vehicle stability. The overall dynamics of the strategy provides a simple, realistic description of the behavior of a car-driver combination.

by E. Eugene Larabee

MIT, Dept. of Aeronautics and Astronautics, Cambridge,  
Mass. 02139Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p200-8  
1975 ; 6refs

Availability: In HS-018 546

HS-018 556

## OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS

A method for the analytical design of vehicles for improved closed-loop dynamic performance is described. The objective is accomplished by the application of modern optimization techniques which determine the values of system parameters that will result in a pre-specified dynamic behavior. The modeling requirements for application of the optimal design method are discussed. An example involving the design of the front-wing of a high-speed racing car to improve cornering performance is given. The example includes the influences of driver control and non-linear vehicle effects on optimal design.

by John W. Zellner; Robert E. Duffy

Rensselaer Polytechnic Inst., Troy, N.Y.

Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p209-15  
1975 ; 6refs

Availability: In HS-018 546

HS-018 557

## TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

A method is developed which relates the design of a submerged vehicle to its performance using hydrodynamic analysis and computer simulation. First the effects of design changes on the vehicle's hydrodynamic coefficients are analyzed and then these coefficients are related to the vehicle's performance by computer simulation. The method provides for the improvement of vehicle design without costly and time consuming scale modeling for each perturbation in design. The generalized equations of motion for submerged vehicles are presented and discussed in terms of their accuracy, flexibility and hydrodynamic coefficients. The specific application of these equations to the Deep Submergence Rescue Vehicle (DSRV) is developed and applied to a general computer simulation. Seven new DSRV designs, perturbations of the original design, are then developed by an analysis which relates changes in the design of the splitter plate and stern shroud to their appropriate hydrodynamic coefficients. Design improvement is measured by simulating the DSRV's performing four common definitive maneuvers and results indicate that improvement is possible by a small increase in the stern shroud's chord length. Other results indicate that in a turning maneuver the splitter plate is as much of a cause for oscillation in roll as it is a damping factor.

by Robert W. Manning; Frank DiCesare; Robert E. Duffy  
Rensselaer Polytechnic Inst., Troy, N.Y.Publ: HS-018 546, International Conference on Vehicle System Dynamics (3rd) Proceedings, Amsterdam, 1975 p216-28  
1975 ; 7refs

Availability: In HS-018 546

HS-018 558

## FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING

A finite element analysis procedure currently being developed and employed for the prediction of large, inelastic deformation

in automotive sheet metal components under crash loading is described. The technique involves a system of local element coordinates that rotate and translate with each element to treat the large deflection aspects of the problem. Results are presented for the dynamic buckling of a spherical dome and for representative vehicle components (hood and door) under impact loads (30, 35, and 55 mph). Mesh drawing for the hood and door are included.

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 Publ: HS-018 546, International Conference on Vehicle System  
 Dynamics (3rd) Proceedings, Amsterdam, 1975 p232-52  
 1975 ; 20refs  
 Availability: In HS-018 546

HS-018 559

#### PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE

The developmental testing of a battery powered compact automobile, a Renault 10 presently being used as a family car, is discussed. Modifications to the battery system and drive train have been made with a view to reducing weight and improving efficiency while maintaining an adequate range and speed for an urban vehicle. A range of 40 to 65 kilometers (km) and an acceleration of from 0 to 40 km per hour in 15 to 20 seconds have been achieved. Tests have also been performed on dynamic braking systems. Accurate records of mileage, driving conditions and electricity usage have been kept over a two year period so that the results of tests can be evaluated and compared. Although the present electromechanical controller has performed well, a solid state controller has been designed to improve the smoothness of vehicle operation.

by Jackson F. Fuller; George E. Gless  
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 Boulder, Colo.  
 Publ: HS-018 559, International Conference on Vehicle System  
 Dynamics (3rd) Proceedings, Amsterdam, 1975 p297-300  
 1975 ; 3refs  
 Availability: In HS-018 546

HS-018 560

#### LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES

Computational formulations for evaluating the limiting performance characteristics of vehicle crash safety devices are presented. Performance is measured in terms of effectiveness in protecting occupants under impact conditions. Depending upon the functional form of the performance index (linear and nonlinear), the resulting optimization problem can be formulated as one of linear or dynamic programming. Numerical results are given.

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 Systems, Charlottesville, Va. 22901  
 Contract NGR-47-005-145  
 Publ: HS-018 546, International Conference on Vehicle System  
 Dynamics (3rd) Proceedings, Amsterdam, 1975 p304-14  
 1975 ; 8refs  
 Availability: In HS-018 546

HS-018 561

#### 1976 DRIVER LICENSE ADMINISTRATION REQUIREMENTS AND FEES

Tabulated information, provided by the State driver licensing authorities, presents the administrative requirements and qualifications needed to obtain driver licenses in the 50 states and the District of Columbia, together with the driver license content and driver improvement provisions as of 1976. Program standards related to the driver are: driver education; driver licensing; motorcycle safety standards; alcohol in relation to highway safety standards; traffic records; emergency medical services; pupil transportation; and accident investigation and reporting. Administrative requirements include: age; restrictions on the operation of motor vehicles by juveniles; renewal of license; drivers license reciprocity; items included on the driver license; license fees; and suspension, revocation, and reinstatement of the driver license.

Federal Hwy. Administration  
 1976 ; 20p

Prepared in cooperation with American Assoc. of Motor  
 Vehicle Administrators, and National Hwy. Traffic Safety  
 Administration.

Availability: Corporate author

HS-018 562

#### THE CARE AND FEEDING OF COMPUTERIZED BRAKES (IF AND WHEN THEY GET HERE)

Federal Motor Vehicle Safety Standard 121 (121) provides new brake standards for new trailers and tractors which are designed to help big rigs stop shorter without jackknifing. This new equipment will require truck operators to adjust maintenance practices to keep the new brake system in good operating order. The 121 brakes have a dual air system that allows the truck to stop if either one of the systems loses air. The system includes an on-board computer which evaluates wheel speeds in a panic stop and makes decisions regarding the extent to which brakes should be applied on each axle. It receives signals constantly from sensors mounted on the rig's wheels and controls the application of brakes on each axle independently through an air modulator valve. All of the companies supplying these systems have training materials on post-121 maintenance available. Skid control manufacturers have also been conducting training schools for truck mechanics and their own field personnel. Since there are very few electronics people in truck maintenance shops, the computer has been designed simply, with the computer units consisting of bolt-on modules which are replaced completely if tests indicate that the unit is faulty. Electrical wiring is the major maintenance concern with the new braking systems, and testing units are available for troubleshooting the systems. A warning system built into the new post-121 trucks and trailers tells the driver if the anti-skid is malfunctioning, in which case the vehicle reverts to conventional braking. In addition to training programs for personnel involved in truck maintenance, audio-visual programs on driver training with the brake systems are also offered to fleets and through branches and dealerships.

Publ: Heavy Duty Trucking v54 n1 p18-24 (Jan 1975)  
 1975  
 Availability: See publication

HS-018 563

### STARTING SYSTEMS (FOR TRUCKS): THE BIG BREAKTHROUGH

A variety of recent breakthroughs in both electrical and air starting systems offer truck operators new opportunities to overcome several of the problems with starting, especially in winter conditions. The start/charge system consisting of batteries, alternators, voltage regulator, starting motor, cables, and connections has traditionally been a major cause of vehicle downtime and maintenance expense. New developments, such as brushless alternators, solid-state rectifiers to eliminate series parallel switches, thick frame starters, and maintenance-free batteries, permit longer service life with little or no preventive maintenance. A survey was conducted which brought responses concerning the battery and cable experiences from 66 fleets. The survey indicated that 59 of the fleets would be willing to pay a premium for a battery which would match current service life but would not require cable maintenance or the addition of water. Of these, 45 were willing to pay at least five dollars extra for this feature. While almost all fleets were willing to pay a little extra for corrosion proof connectors, only 22 would pay at least five dollars extra for the feature. A variety of maintenance-free batteries, which are also designed to withstand vibration, are now available. While conventional batteries must be mounted where they are easily accessible for service, maintenance-free batteries may be mounted virtually anywhere. Improved alternator mountings contribute to extended life for the alternators and starters. The ability of new alternators to perform with virtually no maintenance is due primarily to the use of stationary windings, elimination of electrical wearing parts such as brushes and slip rings, and large-capacity grease reservoirs. It is important to match the quality and capacity of starters, batteries, and alternators to each other and to vehicle demands in order to obtain maximum service life.

Publ: Heavy Duty Trucking v54 n9 p25-9 (Sep 1975)

Availability: See publication

HS-018 564

### AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT

A test program was conducted to study the effects of ambient conditions on exhaust emissions from a variety of automobiles. Twenty-six cars, ranging from 1967 models through catalytic converter-equipped prototypes and cars powered by unconventional engines, such as rotary, diesel, and stratified charge engines, were tested at 20, 50, 75, and 110 degrees F. The 1975 Federal Test Procedure, conducted with engine hoods closed and cooling air flow keyed to vehicle speed, was used to measure emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>), total aldehydes, and reactive hydrocarbons, as well as carbon balance fuel economy. The emissions of all three gaseous pollutants were highest at 20 F for the production cars and catalyst-equipped cars. HC and CO were generally lowest at 75 F, while composite values were greatly influenced by cold start emissions. Composite NO<sub>x</sub> emissions were generally lowest at 110 F and were relatively unaffected by ambient temperature. Fuel economy at 20 F was about 10% lower than at 110 F. The diesel and stratified charge cars had low emissions and little temperature sensitivity. Use of air conditioners at 110 F

caused higher emissions and about 10% lower fuel economy. Reactivity of HC emissions and aldehyde emissions were affected by temperature and were lower from catalyst-equipped cars at all temperatures.

by B. H. Eccleston; R. W. Hurn

Bureau of Mines, Bartlesville Energy Res. Center, P. O.

1398, Bartlesville, Okla. 74003

Rept. No. EPA-460/3-74-028; PB-247 692 ; 1974 ; 152p

Sponsored by the Environmental Protection Agency, Office of Mobile Source Air Pollution Control, 2565 Plymouth Rd.

Arbor, Mich. 48105.

Availability: NTIS

HS-018 565

### REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES

A study was undertaken in Texas to determine methods for making narrow bridges safer without widening them. Bridges on two-lane rural highways have been found to represent minor traffic hazards. The Texas State Dept. of Highways and Public Transportation developed a comprehensive safety program for a section of U.S. route 90, phase of which involved extensive treatment of several bridges. The safety improvements to the restricted bridges on US 90 in Gonzales County were based on the following three principles: that the discontinuous surface of the bridge rail was a significant problem and that a smooth surface would substantially reduce the hazard to motorists; that the lack of continuity of the approach guardrail and bridge rail was a contributing factor; and that the placement of a rail and/or providing full strength connection between the approach rail and bridge rail would substantially reduce the severity of accidents; and that the lack of provision of the restricted roadway width was a possible contributing factor to the accidents and that placement of visible tactile stimuli to guide the driver smoothly onto the bridge would probably reduce the magnitude of the problem. As bridges are not going to be widened, these principles will be the heart of any safety treatment program for the remaining width structures. The treatment applied in accordance with these principles appears to have been extremely effective in reducing the number of reported accidents associated with restricted width bridges in the study area. Some approach and bridge rail collisions after the improvements were reported due to their relatively low severity. Although the absolute number of accidents may not have been reduced as much as the statistics indicate, the reduced severity is nevertheless significant.

by Donald L. Woods; Ben Bohuslav; Charles J. Keesee

Publ: Traffic Engineering v46 n3 p11-6 (Mar 1976)

1976 ; 1ref

Availability: See publication

HS-018 566

### EUROPEAN OILS FOR SPARK IGNITION ENGINES

The design and operating conditions of European gasoline engines, without being basically different from those of American engines, nonetheless have various original aspects, special lubrication requirements resulting from which are reflected in both the composition of motor oils and the bench testing methods. An attempt to analyse the chemical properties and performances in gasoline engines

few recent oils that are representative of the European market is presented. The main properties are: viscometric properties; ash content; elastomer compatibility; volatility; mechanical and thermal shear strength; corrosion resistance; sticking resistance; deposit formation resistance; preignition resistance; and wear resistance. The viscosity characteristics of some of the European commercial multigrade oils are shown in a table. Basically, the oils were: mineral oil including hydrotreated bases; semisynthetic; or synthetic. It was found that performances and formulations of European oils are still very different from one oil to another, but the maximum gaps between them are tending to decrease. Because of relative larger oil sump capacities, oil thickening at high temperatures seems to be less important in Europe than in America. Content and type of metallic ash have to be carefully considered, especially in light of destructive preignition. Compatibility between oils and silicone seals is not fully satisfactory. Viscosities at low temperatures for 20W oils tend to be in a 40-60 poises range at 0 F. For mechanical efficiency reasons, the tendency to high viscosities at high temperatures has probably ceased. The opportunity for development and marketing of synthetic base oils is currently a matter of discussion among engineers. The control of abnormal wear in European engines is very difficult because of the great variety of metallurgical types and designs used in them.

by F. Roux  
Institut Francais du Petrole (France)

Rept. No. SAE-750863 ; 1975 ; 11p 4refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.

Availability: SAE

HS-018 567

### DRIVER RESPONSE TO VOLUNTARY AND MANDATORY SPEED LIMITS

The Highway Research Project at Purdue University analyzed spot-speed observations taken on the Indiana rural highway system to determine the effect of changing maximum speed limits on maximum free-flowing speeds and on speed distribution patterns and to evaluate driver response to voluntary and mandatory speed limits. Data were obtained through spot-speed observations of free-flowing vehicles on level, tangent sections of rural highways during daylight and under favorable conditions, during early 1973, when the maximum speed limit was 65 mph on non-interstate rural highways, and 70 mph on interstate highways; during early 1974, when a voluntary 55 mph speed limit was in effect; and in late 1974, when a mandatory 55 mph speed limit was in effect. The study results indicate that a drop in the maximum free-flowing speeds on the rural highway system, together with a change in the speed distribution patterns, occurred as a result of the changing of the maximum speed to 55 mph. The reduction in the average speeds and in the 85 percentile speeds for 1974 as compared to 1973 was accompanied by a reduction in the standard deviation of the speed distribution together with a reduction in the speed difference. At the same time, the percent of vehicles travelling in the speed range of 51 to 60 mph was increased. This indicates that more vehicles were travelling in a more uniform way in 1974 as compared to 1973, which reduces the conflict between vehicles and may account for the reduction in accidents. Driver response to speed limits was dependent on the mandatory aspects of the limit. Drivers responded to the voluntary 55 mph limit, but not to the same degree as to the mandatory one. The average speed decreased and the speed

pattern changed and became more clustered around the average speed during the mandatory 55 mph period as compared to the voluntary period.

by Ahmed Atef Gadallah

Publ: Traffic Engineering v46 n3 p32-5 (Mar 1976)  
1976

Availability: See publication

HS-018 568

### V DRIVE (NEW FOUR WHEEL DRIVE SYSTEM)

A new full-time four-wheel-drive (4wd) system utilizing independent front suspension, the Spicer V-Drive system, is discussed. The system receives its name from the layout of the two forward driveshafts, which is in the shape of a Vee. The V-Drive was designed to obviate the stiff, choppy ride of beam axle 4wd, and to replace it with the more acceptable ride of independent front suspension. The Spicer system incorporates independent axle carriers, so that the engine may be located closer to the axle, and a tall vehicle profile becomes unnecessary. Ground clearances, however, can be improved because transfer case, shafts and carriers do not extend downward. A Mercury sedan was equipped with the Spicer system and was found to perform in very bad winter driving conditions exactly as a conventional 2wd Mercury does on a dry summertime pavement surface. Photographs of different facets of the Spicer system are included.

by Dave Epperson

Publ: Pickup Van and 4WD v4 n8 p52-5 (May 1976)  
1976

Availability: See publication

HS-018 569

### IF THE TIRE FITS, BUY IT

Information on the biggest tires that can be conveniently fitted onto pickups, vans, and four-wheel-drive vehicles of various makes is presented. Modifications such as trimming of the vehicle's fender lips and smoothing-up of disc brake calipers will probably be necessary when fitting vehicle with bigger tires. The effects of large tires on gearing, the use of chains, tire rotation, and steering effort are discussed.

by James T. Crow

Publ: Pickup Van and 4WD v4 n8 p59-63 (May 1976)  
1976

Availability: See publication

HS-018 570

### FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974

An annual summary for 1974 is provided showing fatal and injury accident rates on federal-aid highway systems. Tables show fatality rate trends by highway system (rural, urban, local and interstate) and state; injury and injury accident rates by highway system and state; fatal and injury accident data related to vehicle registrations, populations and licensed drivers; fatalities, fatal accidents, and travel; and injury accidents, per-

sons injured, and travel for federal-aid interstate, secondary, local and other federal-aid primary roads.

Federal Hwy. Administration

Rept. No. AR-8 ; 1976 ; 44p

Availability: GPO \$1.05, stock no. 050-001-00106-3

HS-018 571

## ALTERING FRONT AXLE ALIGNMENT

The subject of achieving the best performance from a front axle assembly is reviewed. One adjustment involves bending the right side of the axle to the point where the front wheel is set at zero camber. The left side of the axle is usually left at the factory camber setting. In this way, the compression is straight down on the tire instead of on the outside shoulder where rapid tire wear can occur. The axle bending operation, which can be done in most truck alignment shops, costs on an average of \$35.00 to \$45.00, and can be done in two hours. No heat is applied, so there is no effect on warranties. Several fleets which have adopted the zero-camber right front wheel setting report improved front tire mileage. Axle manufacturers, however, while admitting that the zero-camber setting might produce good results under certain road conditions, say that camber settings from the factory are aimed at producing the best overall performance in tire wear, ride, and handling under the variety of road conditions a truck must cover. Other topics which were discussed at the Regular Common Carriers Conference (RCCC) in North Carolina included a panel discussion on the future of city pick up and delivery truck engines; protecting fleet tools when mechanics are off-duty; and incentive programs for maintenance supervisors.

Publ: Heavy Duty Trucking v52 n3 p34-7 (Mar 1973)  
1973

Availability: See publication

HS-018 572

## GETTING THE MOST FROM YOUR BRAKE LININGS

How long a set of brake linings lasts, and how good a job it does of stopping a truck are matters that are principally up to the truck operator and/or his maintenance crew, and the lining chosen. Stopping power and lining life become even more critical in light of Motor Vehicle Safety Standard 121, which specifies maximum allowable stopping distances for air-braked highway trucks. The key consideration in setting up the brake system is selecting the right lining for the service each rig is going to be handling. If hauls will be made primarily over freeways, with little or no travel over mountainous country, then extra heavy duty or "super" linings should not be used. When choosing a lining, the safest bet is one with balanced characteristics that does a good job under all conditions. Another important area is matching the lining to the drum that is being put on a truck or rig. The wrong lining on the wrong drum can result in hard wear and short life. Delivery of air in an air brake system should be balanced throughout the system, with all brake chambers receiving the same pressure. A lot can be learned about what brakes are doing wrong when the wheels come off in the shop. The wear pattern of the linings can tell what shape the drum is in. For instance, if the lining centers show all the wear, the drum may be oversize; a ridged lining surface means a scored drum; tapered wear from side to side on the lining indicates a "bell-mouthed" drum. Other

items to look for are: frozen anchor pins; excessive wear on shoe parts; out-of-round drum; distorted or loose brake spider; worn slack adjuster; camshaft play; flat spots on rollers; and enlarged anchor holes in shoes. A "Friction Pair" concept program is described, in which a highway rig recently reached 210,499 miles and still had one-half the wearing surfaces intact. The difference in the system, which employed standard linings, was in the drums, which had been specially formulated and poured to match the friction material in the linings. A fast brake system is described which consists of valve relays that speed air brake control signals to the rear of the tractor-trailer combinations, resulting in brake activation up to 40% faster than without the system. Also described is a Uni-bond brake shoe assembly, which offers quick, economical, and long-lasting brake life.

Publ: Heavy Duty Trucking v52 n3 p38-42 (Mar 1973)  
1973

Availability: SAE

HS-018 573

## FIGHTING FRONT TIRE FAILURES

A study conducted by the United States Bureau of Motor Carrier Safety (BMCS) indicates that tire failures are the number two equipment safety problem and that 60% of all tire failure accidents are caused by front tire failures. The study was based on accident reports submitted by interstate motor carriers and on three investigations conducted by the BMCS staff. In many cases, front tires were found to be underinflated or overloaded. It is suggested that proper pre-trip inspection of tire pressures by either the carriers or the drivers could assist in protecting against tire failures. Right front tires were found to fail consistently more often than left front tires, probably because of the greater likelihood of the right front tire hitting curbs and shoulders and by additional weight on the right side of the truck caused by the crown on many roads. About 23% of the tires which failed and caused accidents were tubeless, although they account for only about 15% of the heavy duty truck tires on the road. Although the study indicated that worn tread was not a major cause of front tire failures, the study did show that tires involved in front tire failure accidents tend to have slightly less tread pattern depth than other front tires. Worn tread may be a factor in skidding accidents. A study of 61 accidents involving front tire failure showed that nine of the tires failed in 10,000 miles or less, while only five of the failed tires had run over 70,000 miles before failing.

Publ: Heavy Duty Trucking v52 n4 p42-4 (Apr 1973)  
1973

Availability: See publication

HS-018 574

## HOW TO INCREASE BATTERY LIFE

Research has shown that vibration, location of batteries, hold-down devices, trays, and charging systems are vital to long battery life in trucks. Excessive vibration causes truck batteries to gradually lose power and eventually fail before they should. The Regular Common Carrier Conference Maintenance Committee has recommended practices on batteries and cable assemblies designed to prolong the life of these units. Batteries mounted between frame rails were found to experience minimum vibration and longest life. Batteries must be mounted

where they are accessible in order to facilitate servicing. Truck operators should be sure to use heavy duty retainers for the batteries which are solid, secure, and properly supported. The retainer should be made from or treated with a corrosion resistant material. Fasteners or bolts used to anchor retainers should be tightened equally to 50 to 70 pound inches. Over-tightening or unequal tightening can damage the battery. The discharge characteristics and life expectancy of the battery are greatly affected by the method used for charging. Persistent undercharging results in short battery life and poor starting performance. Common sense should be used in routing battery cables, placing them so that areas where they may be scuffed or wear through are avoided or minimized.

Publ: Heavy Duty Trucking v52 n5 p40-3 (May 1973)  
1973

Availability: See publication

HS-018 575

### SMALL FLEET SAFETY PROGRAM

The American Trucking Association's Safety Department has developed a Small Carrier Safety Program for fleets with 25 trucks and under. The program, which is adaptable to both intra- and interstate operations, is designed to help small fleet operators to reduce insurance premiums, accident possibilities, lost equipment, repair costs, and cargo damage. This safety program includes sound hiring procedures, personnel orientation and training, driver controls and supervision guidelines, vehicle inspection and maintenance programs, methods for maintaining desirable employee attitudes and morale, records and reports, and occupational safety programs. An outline of Department of Transportation regulations in each of these areas and of sources of information or recommendations for compliance and/or procedures in each aspect of the total safety program and a basic outline of recommended practices and of references for further information and suggestions for compliance and improvement of present practices are provided.

Publ: Heavy Duty Trucking v52 n7 p34-7 (Jul 1973)  
1973

Availability: See publication

HS-018 576

### BEATING THE OBLLOWOUT WIPEOUT'

Factors involved in front tire blowouts on heavy-duty tractor-trailer trucks and preventive measures that may be taken to reduce the probability of their occurrence are discussed. The use of power steering, steering stabilizer systems, and radial tires to increase control in the case of blowout and to increase tire mileage is considered. Brief descriptions of actual blowouts and photographs of blown tires are presented. Also, tips on tire care, the use of tubes, and wheel and rim maintenance are given. Significant changes in truck tires coming in the near future are mentioned.

Publ: Heavy Duty Trucking v52 n10 p37-41 (Oct 1973)  
1973

Availability: See publication

HS-018 577

### LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION

An investigation was conducted of the crankcase oil viscosity required to start the most representative engines of the Italian car population as a function of the ambient temperature. In order to start an internal combustion engine, the cranking speed must equal or exceed the minimum starting speed of that engine. The viscosity requirement of an engine, at a given temperature, represents the highest value of the sump oil viscosity above which the cranking speed does not exceed the minimum starting speed. The viscosity requirement is determined by measuring the engine cranking speed versus the oil viscosity and ambient temperature and determining the minimum starting speed. Four single grade naphthenic oils were used in these tests. A total of 22 engines were tested, most of which were four-stroke engines. On the basis of the data obtained through these tests, a family of satisfaction curves was obtained representing the percentage of cars that can be started with a given oil as a function of the ambient temperature. These data indicate that even in the most severe Italian weather conditions, 92% of the Italian car population can be started with a 20W-X oil. If a 15W-X oil is used, 98% of the car population can be started under all weather conditions, while practically all cars can be started if a 10W-X oil is used.

by M. Belati  
Essotech (Italy)

Rept. No. SAE-750864 ; 1975 ; 16p 6refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.

Availability: SAE

HS-018 578

### EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS

European automotive cams and followers utilize a much wider variation in metallurgy, design, and running speed than do American counterparts. A survey was conducted to collect information on service experience, materials and finishes, lubrication, and existing test methods in order to develop comprehensive test procedures for European cams and followers. The survey indicated that the types of failure which occur in cams and followers are scuffing, polishing wear, and pitting, with scuffing being the most serious problem. The likelihood of any particular form of failure occurring is dependent not only on the level of loading, operating speed, and temperature, but also on the type of lubricant, the material, and the surface condition. Experience indicates that there is a need for an adequate supply of lubricant and that forced feed to the cam/follower interface or oil baths into which cam lobes can dip are superior to other methods. The materials used mostly for cams and followers are: chilled cast iron; hardenable cast iron; hardened and tempered chilled cast iron; spheroidal-graphite cast iron; induction hardened steel; and carburized steel. The durability and mode of failure of the cams and followers can vary markedly depending on the ability of the materials chosen to work in combination and on the lubricant. The ability to operate satisfactorily with a wide range of oils is clearly a desirable feature. Special surface treatments may be beneficial with some materials. Extensive laboratory studies resulted in the determination of good combinations of cam and follower materials and treatments, five of which are relatively in-

sensitive to the type of oil used in the tests. However, the combinations of materials found to be best are different from almost all the combinations of materials currently employed in automobile engines in both Europe and America. The various combinations adopted by manufacturers were included in the tests but were generally not found to compare very favorably with the preferred combinations. A large variety of engine tests to be used in formulating automotive lubricants are necessitated by the wide differences in engine materials, designs, and operating conditions. A test method with a cam and follower test machine is currently being developed. It is believed that a significant amount of the difficulty and cost of matching lubricants to engines can be removed with a machine of this kind. The machine permits five cam and follower pairs to be run simultaneously under identical conditions or with different loading conditions with a common oil supply and with running conditions varied over a wide range.

by R. J. Love; F. C. Wykes  
 British Technical Council of the Motor and Petroleum  
 Industries  
 Rept. No. SAE-750865 ; 1975 ; 11p 2refs  
 Presented at the Automobile Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.

Availability: SAE

### EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST

Valve train wear performance of crankcase oils and their components was evaluated in 20-hour Volvo 2-liter engine tests. The Volvo B20 engine used is a 2-liter push rod operated valve gear engine having a flame hardened cast iron camshaft and chilled cast iron tappets. The tappets were surface treated by either parco-lubrizing or ferro-oxidizing. A total of 72 tests were conducted, with each engine test being conducted in duplicate, triplicate, or quadruplicate on a number of oils in order to determine repeatability. Test results demonstrate that specifying a minimum zinc level in an oil does not necessarily assure freedom from cam and tappet wear. The interface effect of the detergent inhibitor package (DI) on the functioning of the anti-wear additive was clearly demonstrated. Case studies of lubricants at different performance levels highlighted the effects of viscosity index improvers (VII), oil quality variation, tappet surface treatment, effectiveness of various zinc dialkyldithiophosphate agents (ZDDP), and failure mechanisms. Test procedure investigations were conducted to evaluate the precision of the method, the effect of cycle time on the failure rate, and test engine life.

by B. B. Slater  
 Gulf Res. Laboratoria B.V. (Netherlands)  
 Rept. No. SAE-750866 ; 1975 ; 18p 8refs  
 Presented at the Automobile Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.

Availability: SAE

### THE WATER-COOLED VOLKSWAGEN PCI- STRATIFIED CHARGE ENGINE

The development of a 1,600 cubic centimeter stratified charge engine (SCE) with a divided combustion chamber and fuel injection into the prechamber is described. Single cylinder engine tests indicated that a fuel mass fraction of 0.05 to 0.25 for

the quantity injected into the prechamber was optimal of emissions and fuel consumption. The relative air-fuel ratio in the prechamber is then about 0.7 to 0.8. A mathematical simulation model of a water-cooled prechamber injection SCE was then used to study several parameters. The simulation tests indicated that average exhaust gas temperature change very little with a very significantly delayed combustion with its associated reduction in indicated mean pressure, maximum cylinder gas pressure and a strong increase in temperature in the cylinder at the exhaust valve closing. While it is easily possible to operate the SCE on various mixtures, it was found to be advantageous from an engine point of view to tune the engine for a total relative air-fuel ratio of 1.10 to 1.30. This is also the region where the reactor is most effective. The test Volkswagen PCI-SCHE engine could meet the current California emissions standards. An extensive optimization effort is still needed to reduce hydrocarbons of less than 0.41 grams per mile without a catalytic converter when the present fuel consumption figure is to be maintained. Octane requirements are relatively low, particularly at high speed. No soot formation or exhaust smoke was noticed, nor was the engine noise different from that of conventional Otto-engines. No significant problems which are tributable to the stratified charge combustion were observed during the testing of engine dynamometers or in vehicles on the roads.

by W. R. Brandstetter; G. Decker; K. Reichel  
 Volkswagenwerk AG, Res. and Devel. (West Germany)  
 Rept. No. SAE-750869 ; 1975 ; 13p 13refs  
 Presented at the Automobile Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.

Availability: SAE

### DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE

The development of the five-cylinder Mercedes-Benz OM 617 engine (the OM 617) for use in passenger cars is described. While the concept of a five-cylinder in-line engine has been realized as stationary engines and engines for heavy-duty vehicles, the OM 617 represents the first application in a passenger car. Research on vibrational behavior has shown that a five-cylinder engine with even firing intervals of 120 degrees due to the symmetry of its crankshaft displays balanced inertia forces of first or higher order, while balanced couples do exist due to the uneven number of cylinders. Torsional vibration dampers are necessary in order to keep vibrations and torsional stresses in the crankshaft as well as their excitation of noise in the timing gear, oil pump, transmission and driveline at an acceptable level. Two shock absorbers parallel to the front mounts of the engine are used to reduce vehicle vibration upon starting and stopping of the engine. The engine/torque converter/transmission connections are strengthened, raising the natural frequency of the total system to such a degree that operation below the natural frequency is always guaranteed. The main design features of the engine are described and illustrated. The OM 617 is equipped with a most statically controlled air/oil heat exchanger which ensures a short warm-up phase and meets the demands of external cooling in the case of high loads. A prechamber cooling system has been selected, since it presents the best compromise between the demands for good fuel economy, low emissions, low noise levels, and good startability. The engine carries a Bosch five-plunger-in-line injection pump.

mechanical governor attached to the side of the crankcase. The injection pump is connected to the lubrication circuit of the engine and is maintenance-free. Improved performance of the five-cylinder engine provides the vehicle with extraordinary acceleration as compared to previous diesel vehicles. The exhaust emissions of the vehicle with the five-cylinder diesel engine are low, being well under the 1975 to 1976 standards.

by Kurt Oblander; Manfred Fortnagel  
 Daimler-Benz AG (West Germany)  
 Rept. No. SAE-750870 ; 1975 ; 13p 7refs  
 Presented at the Automotive Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.  
 Availability: SAE

HS-018 582

### COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS

Five types of catalytic structures devised for automotive honeycomb catalytic converters, all of whose honeycomb meshes vary in shape, were compared. Analytical models were prepared in a two-dimensional frame structure in which each mesh was composed of many beams. These models were then used to obtain the respective levels of thermal stress and thermal strain when axi-symmetric stationary temperature is distributed, which is the most severe thermal stress of each structure when measured in thermal shock tests. By examining the analytical results from various angles, a study was made concerning the heat-resisting properties of the meshes in respective shapes, including regular triangle, regular hexagon, square, and two types of corrugation meshes. The maximum value of axial stress, and of resultant stress all occur at the periphery, with the regular hexagon and one type of corrugation showing great thermal stress. The stress distribution on each type of honeycomb was found to be related to the stress distribution on the solid disk and to the equivalent elasticity coefficient of the mesh structure. The smaller the equivalent elasticity coefficient the better the heat-resisting properties of the structure. The deformation of each type of honeycomb can be estimated by a wire model or by a sheet-metal model. The direction in which each honeycomb type will tend to crack can be determined from the stress distribution and the anisotropy of the mesh structure in that type. In the honeycomb with the outer cover, great tensile stress and bending stress are produced on the outer cover. In proportion to the thickness of the outer cover, compressive stress in the inner area increases, but tensile stress on the outer cover decreases. The magnitude of stress generated on the circumference is proportionate to the difference between temperatures at the center and on the circumference, and also to the temperature gradient.

by Mizuho Fukuda; Kazuo Osada  
 Nissan Motor Co., Ltd. (Japan)  
 Rept. No. SAE-750872 ; 1975 ; 23p 4refs  
 Presented at the Automotive Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.  
 Availability: SAE

HS-018 583

### APPLIED PHOTOLELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS

Three practical applications of two-dimensional and three-dimensional photoelasticity to engine component design and failure analysis are discussed. The three applications discussed include: photothermoelastic analysis of spark ignition engine exhaust manifolds; load distribution on the front roller of three-quarter inch ball-roller water pump bearings; and valve stem stress distribution for four keeper groove design. This stress analysis technique provides whole field stress distribution and can be used to optimize a design by obtaining even stress distribution. The analysis of exhaust manifolds involved the construction of a three-dimensional plastic model of the manifold to be tested. The use of photothermoelastic plastic techniques has allowed study of exhaust manifold failures and possible solutions for some of the failures, as well as study of new designs to try to eliminate points of failure. A three-dimensional photoelastic model and stress freezing technique were used to determine the exact location of the center of pressure on each roller bearing for use in a computer program developed to determine the water pump bearing life. A two-dimensional model of the valve stem was made of photoelastic material for use in determining the stress concentration factor for the four groove design used in exhaust and intake valves.

by A. K. Goyal; E. I. Watkins  
 Ford Motor Co.  
 Rept. No. SAE-750881 ; 1975 ; 14p 9refs  
 Presented at the Automobile Engineering Meeting, Detroit,  
 Mich., 13-17 Oct 1975.  
 Availability: SAE

HS-018 584

### CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230

The connecting rod bolted joint has the function of directing the power flow of the maximum inertial forces of the reciprocating piston of an internal combustion rod via the connecting rod bearing cap to the crankshaft. The dependencies of the forces and moments in the joint face on working force and distribution of flexural rigidity were examined with the aid of three typical designs of a substitute ring for the connecting rod big end: substitute ring loaded symmetrically to joint face with constant moment of inertia; symmetrically loaded substitute ring with symmetrically discontinuously variable moment of inertia; and symmetrically loaded substitute ring with asymmetrically discontinuously variable moment of inertia. Calculation of the connecting rod bolted assembly was then carried out with the aid of the sequence of mathematical steps recommended in VDI 2230. The calculated bending stresses were satisfactorily confirmed by measurement at maximum bearing clearance. The five possible causes of failure of the connecting rod were determined to be: lifting in the joint face; transverse displacement at the joint face; exceeding the yield point in the bolt shank; flexural fatigue fracture in the first load bearing screw thread; and plastic deformation under compressive

stress. The first two of these possible causes of failure are least safe with a maximum tightening factor.

by A. Grotewohl  
Volkswagenwerk A AG (West Germany)  
Rept. No. SAE-750882 ; 1975 ; 12p 3refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 585

### INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

The indiscope is a new instrument for measuring combustion pressure. This new pressure indicator consists of a molded ring of the same size as the usual washer fitted at the neck of a spark plug and can therefore be easily installed on a vehicle without altering any part of the engine in question simply by replacing the usual washer with the pressure pick-up ring. The indiscope consists of an even number of rings of thin sheets of piezoelectric transducer (PZT) sandwiched by three metal sheets, with all elements molded together into a solid ring with the middle sheet serving as an output electrode and the top and bottom sheets serving as ground electrodes. Two elements are provided for detecting the crank angles: one is a sheet-plastic disc with a special toothed pattern which is glued to the front pulley of the crankshaft and the other is an optical counting head which is fixed to the engine block with a bolt or a magnetic fixture. This indicator permits one to observe the real working behavior of engines, both transient and steady state, in laboratories and on the open road. The compressive stress of the ring washer transducer decreases or increases as the combustion pressure increases or decreases, and accordingly electric signals appear at its output electrode. Several examples of indicator diagrams, unfamiliar and unexpected as well as normal, are presented. It is suggested that although no satisfactory means of calibrating the pressure scale of the indiscope including its frequency characteristics has yet been developed, the instrument is nevertheless useful to observe, cycle after cycle, the inner phenomena of every cylinder.

by M. Kondo; A. Niimi; T. Nakamura  
Gakushuin Univ. (Japan); Rion Co., Ltd. (Japan)  
Rept. No. SAE-750883 ; 1975 ; 9p  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 586

### CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH

Three basic methods are used in the design and selection of heat exchangers: the Log Mean Temperature Difference Method; the e-NTU Method; or the Unit Core Heat Transfer Capability Method. The Unit Core Heat Transfer Capability Method is the one generally used in the preliminary analyses of heat exchanger core in the automobile industry. This method relies on the correlation of data between unit core heat transfer capability and air flow velocity in front of the core. These correlation data are usually obtained in a wind tunnel using a 12 inch by 12 inch or a 6 inch by 6 inch basic core.

When the tube length is different from the basic core length, correction of the heat transfer performance of the core should be made. A mathematical formulation of this correction factor has been developed. The application of the correction factor to the following four commonly used liquids which require cooling in an automobile is demonstrated: water; 50/50 aqueous ethylene glycol solution; engine oil; and hydraulic fluid. Extensive data are presented for each of these applications of the mathematical formula.

by Jiunn P. Chiou  
University of Detroit  
Rept. No. SAE-750884 ; 1975 ; 15p 10refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 587

### TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS

A constant temperature hot wire anemometry system has been developed to study the turbulent flow conditions in spark ignition engine combustion chambers. A detailed analysis was conducted to ensure that the anemometer bridge was balanced at both high and low flow velocities. In addition, an extensive analysis was undertaken, based on both theoretical calculations and experimental measurements, to ensure that the probe-anemometer frequency response was adequate for measurements of flow fluctuating velocities up to 6,000 Hertz (Hz). This analysis was conducted at ambient conditions and at conditions similar to those existing in a 0motored' engine combustion chamber at the end of the compression stroke. The noise characteristics of the anemometer were also investigated to ensure that this could not interfere with or obscure turbulence measurements in the high frequency region of the flow to be investigated. Comprehensive procedures were adopted to calibrate the probe. The anemometry system was then used to study the turbulent flow conditions in two extreme cases: a 0squish' combustion chamber design and a cylindrical disc combustion chamber design. These studies demonstrated that most of the turbulent energy in all chamber forms is contained in the frequency range below 700 Hz. The main effect of a change in combustion chamber shape was found to be an alteration in the magnitude of the flow fluctuating velocities below 1,600 Hz. The higher frequency fluctuations remain, to a large extent, relatively unaffected. In all chamber designs, the low frequency fluctuations below 200 Hz increased in a linear manner with engine speed. It is concluded that the experimental observations demonstrated that a hot wire anemometry system can be used most effectively for the investigation of the turbulent flow conditions in spark ignition engine combustion chambers.

by E. H. James; G. G. Lucas  
Loughborough Univ. of Technology, England  
Rept. No. SAE-750885 ; 1975 ; 20p 10refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

## THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER

A method has been developed for the determination of the turbulence characteristics of internal combustion engine cylinders using hot wire anemometry and high speed random signal data processing techniques. Turbulence output from a hot wire anemometer attached to an engine was recorded on magnetic tape. A Signal Processing Computer with a high-speed Analog-Digital Converter was then used to synthesize from a large number of data for consecutive cycles a turbulence record over a small crank angle interval, at a particular position of interest in the engine cycle. Experimental tests were conducted on two commercial engines having different combustion chamber geometries. In each case, only one cylinder was instrumented for the tests. The results obtained from these two spark ignition engines indicate results for the general characteristics of gas mean velocity, turbulence velocity fluctuation, Spectral Density Distribution which are in general agreement with the findings of other workers in the field. Results of measurements of Micro and Macro-scales of Turbulence in engine cylinders are presented for the first time.

W. C. Dent; N. S. Salama  
Loughborough Univ. of Technology, Dept. of Mechanical Engineering, United Kingdom  
Rept. No. SAE-750886 ; 1975 ; 14p 18refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

## A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER

Operation of a spark ignition engine under lean mixture conditions is one of the several options that may be used to meet pollution and fuel economy standards. In such an operation, various factors influence the combustion phenomenon. To examine these, a study was conducted in a static chamber using propane air mixtures of different stoichiometry. Effects of ignition energy, electrode geometry, location of the ignition source and the temperature profile in the initial reaction zone were investigated. It was found that increasing ignition energy accelerated the flame up to a certain point. Any further increase in energy had little effect on the flame acceleration. The rate of pressure rise also showed a similar pattern. Temperature in the reaction zone was lower when the ignition source was near the wall than away from it. The temperature profile was mapped using laser interferometer techniques. Flat tipped electrodes showed better repeatability and tended lower ignition energy than the flat tipped.

Keshav S. Varde  
University of Michigan, Dearborn  
Rept. No. SAE-750887 ; 1975 ; 12p 19refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

## COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

The development of vehicle combustion is characterized by the effort to reduce exhaust gas emission and fuel consumption and to conserve the good properties of the combustion engine at the same time. Porsche of West Germany is intensely investigating the further development of the conventional combustion engine as well as of the stratified-charge-chamber engine. With the stratified-charge engine (SKS), Porsche has attempted to create optimum conditions for each of the combustion phases. The result was a divided combustion chamber with a three-stage combustion. The system was tested on single-, six-, and eight-cylinder engines and led to positive results under stationary conditions as well as some good results under unstationary driving conditions. Basic tests with one-cylinder and with multi-cylinder engines indicated a high operating stability throughout a wide speed and load range. The operating process of the SKS engine is approached to the theoretical cyclic process with isothermal expansion, which seems more advantageous than previous theoretical processes, with a view to the simultaneous reduction of the undesirable exhaust gas components and the lessening of fuel consumption.

by Dusan Gruden  
Porsche (West Germany)  
Rept. No. SAE-750888 ; 1975 ; 17p 22refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

## DRIVER SAFETY IN MODIFIED VANS

The concept of a handicapped driver remaining in his wheelchair while at the controls of his automobile van is now a reality. The modification of "van-type" vehicles to permit easy access by an unaided handicapped person however, is a bit more difficult in the case of a moderately severe quadriplegic. Mobility Engineering has developed a driving system addressed to the quadriplegic who has limited power and range of motion but reasonable eye-to-hand coordination. The system consists of fully boosted steering and brakes and throttle controls brought to a single lever within easy reach of the patient. A new seating arrangement was also developed which is adjustable, maneuverable, and has sufficient structural integrity to meet the Department of Transportation's restraint requirements. In the van, suspension is accomplished by attaching the wheels to the center driver section by two leading and two trailing arms. The trailing arms incorporate the driving motors and driver train for the rear pneumatic tires and wheels. The system, so far, has taken 8 years to develop. Although imperfect at present, it is hoped that continuing development will bring the systems nearer the ultimate goal. Drawings show the seating system, and photographs are provided of the van interior.

by Charles M. Scott  
Publ: Bulletin of Prosthetics Research p377-87 (Fall 1974)  
1974  
Availability: See publication

### A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES

Three studies focusing on the relationship of reported seat belt usage to seat belt attitudes and other variables were carried out between 1973 and 1975 by separate investigators. An outline of each study's methods, analyses, and major significant findings is given, followed by a comparison of results across studies. It was found that seat belt usage was associated with the presence of a warning system, good seat belt design, higher education and occupational status, ownership of late model cars, attendance at driving school, and a tendency to derive information about seat belts from driving schools and from newspapers. An economic explanation encompassing all variables is to the effect that the less well educated driver, having a lower occupational status, and therefore less income, owns an older automobile equipped with an uncomfortable seatbelt. At the same time, he is less inclined to expose himself to or to absorb accurate seat belt information. Additional evidence, suggesting that the user is safety and risk conscious while the nonuser reports discomfort and non-effectiveness, supports the above interpretation. Habit, strongly implicated as an important factor with respect to both usage and non-usage, is seen by the reviewer as post-decisional and, therefore, relevant to maintaining, rather than to bringing about, the desired behavior change. The data on seat belt legislation suggests that most individuals are favorable towards compulsory seat belt usage and that, of those who are not habitually wearing belts now, most would increase usage under a law. Opposition is estimated at only about 14 to 15%.

by Ruth M. Heron  
Ministry of Transport, Motor Vehicle Traffic Safety Branch,  
Ottawa, Ont., Canada  
Rept. No. CR-7503 ; 1975 ; 85p 9refs  
Cover title: Attitudes Towards Seatbelts. Text also in French.  
Availability: Corporate author

### DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION

A study to investigate the ability of subject drivers to detect oncoming vehicles with their low beam headlights 'on' and 'off' under various levels of daytime illumination is presented. The drivers for the experiment were six male volunteers, each screened for normal corrected vision. The remaining two were from the Defense and Civil Institute of Environmental Medicine. The experiment was performed on a 7,000 foot runway of the Canadian Forces Base Toronto. The experimental vehicles were two identical 1974 Plymouth Furys with automatic transmissions. The experiment consisted of eight experimental sessions, followed by 16 trials in which drivers were instructed to respond when they detected the approaching vehicle by pushing a button mounted on the steering wheel. Results indicated that the study vehicles could be detected sooner with their headlights on. Detection distance in the 'lights-on' condition was essentially constant over the range of illumination investigated. In the 'lights-off' condition, detection distance decreased, in an approximate linear fashion, with a decrease in the logarithm of ambient illumination. Results are discussed in terms of passing performance on two-lane

highways, and in terms of the design of appropriate running lights. Photographs of the test situation are p

by D. A. Attwood  
Ministry of Transport, Road Safety Unit  
Rept. No. RSU-75/2 ; 1975 ; 21p 17refs

Prepared in cooperation with Canadian Forces Base and the Defence and Civil Institute of Environmental Medicine.

Availability: Corporate author

### SAFETY OF PEDESTRIAN CROSSING FACILITIES

International comparative statistical research was undertaken to establish the relationship between the existence of pedestrian facilities (zebra crossings, signal controlled crossings, grade separated crossings) and the relative risk to pedestrians crossing urban roads. In three of the six areas investigated (The Netherlands, United Kingdom, United States, and Sweden, Spain, Germany and Austria), it was found that the pedestrians' relative risk is reduced as more signal controlled crossings are provided. In two countries, this reduction was found only for zebra crossings. In only one country no correlation was found at all between pedestrian facilities and relative risk. With the method used in the research (comparing levels of pedestrian safety in towns divided by variously composed sets of pedestrian crossing facilities) it could not be demonstrated in the case of the Netherlands that increasing the number of zebra crossings promoted pedestrian safety. Making more signal controlled crossings, however, have a favorable effect on pedestrian safety. The criterion of exposure used in the research is recommended for similar research. Appendices include: calculation of the number of potential collisions and of the relative risk scheme for the calculation of the relative risk; and the questionnaire used during investigation of accidents in a town.

Institute for Road Safety Res. SWOV, P. O. Box 71, Deernsstraat 1, Voorburg 2119, The Netherlands  
Rept. No. Pub-1974-2E ; 1974 ; 54p 9refs  
Availability: Corporate author

### ENERGY AND TRANSPORTATION

An all-day forum on "Energy and Transportation" was part of the 1975 National Automobile Engineering Conference. The forum was organized to consider the transportation needs for various forms of energy and the long-term availability of such energy sources. By invitation, 12 papers were presented dealing with the transportation energy needs of the nation. Some attention was also directed toward alternate energy sources which might alleviate our dependence upon petroleum. Topics included: the economics of energy policy; energy needs; energy utilization by various modes of transportation; energy sources and future availability; fuels for transportation; non-transportation uses for petroleum, imports and availability; alternative automotive engines and energy

vation; alternate transportation fuels; and the investment picture of United States energy needs.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096  
Rept. No. SAE-SP-406 ; 1976 ; 70p refs  
Papers presented at an all-day forum, "Energy and Transportation," 15 Oct 1975, as part of the 1975 National Automobile Engineering Meeting, Detroit.  
Availability: SAE

HS-018 596

### DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS

A study investigating driver expectancy and performance in locating automotive controls was undertaken in four major phases: a problem analysis aimed at establishing through field surveys an empirical data base that would help answer the questions of what controls ought to be standardized; a series of methodological studies to develop and evaluate the experimental techniques that could be applied to the problem; a major survey study designed to obtain detailed information describing driver expectancy for automotive control locations and to identify the factors that influence those expectancies; and an experimental study of control-locating performance that was designed to measure the effects on driver performance of the discrepancy between the actual locations of automotive controls and the locations expected by individual drivers. The application of human performance criteria resulted in the following recommendations for control location standards. The headlight switch and the wiper/washer control unit should both be located on the left panel, with the headlight switch above or outboard of the wiper control. The radio and climate control units should be located on the right panel. The cigarette lighter and ashtray should be located within a zone that may include the lower part of the right panel, the edge of the panel, and the upper part of the console. An international agreement should be sought to standardize the location of the hazard flasher switch either to the steering column or to the instrument panel, and further to specify the left side or the right side as the standard location. The vent control should be integrated with the functions contained within the climate control unit. These recommendations are based solely on the factors that influence the speed and accuracy with which automobile drivers can locate and identify the controls.

by James J. McGrath  
ANACAPA Sciences, Inc.  
Contract 14.1  
Rept. No. SAE-SP-407 ; 1976 ; 179p 4refs  
Supported by the Motor Vehicle Manufacturers Assoc.  
Prepared in cooperation with the Testing Task Force of the Controls Location, Identification and Effort Subcommittee of the SAE Human Factors Engineering Com.  
Availability: SAE

HS-018 597

### CHILDREN AND ROAD SAFETY: A SURVEY AMONGST MOTHERS

Interviews were conducted with 2,017 mothers of children 2-8 years old in England, Scotland, and Wales regarding their children's use of roadways. Previous studies have demonstrated that the over-riding factor affecting the chances that a child

will play in the street, ride a bicycle on the road, walk to school alone, and similar activities, is his age. At two years he is unlikely to be allowed to do any of these things; but at nine years he is permitted to do all of them. Further investigation reveals that other factors, such as social class, position in the family, and sex, have little or no influence on the likelihood of the child being allowed on the road for whatever purpose. The incidence of street-playing is higher among boys than girls; among town-dwellers than country children; among children who live in homes without gardens than those who have gardens; and among children whose homes are on estates rather than those whose homes are not. On the other hand, neither social class of the child's father, nor his income affects the likelihood of the child playing in the street. Age is the single determining factor influencing the mother in her decision on whether or not to allow the child in the street for whatever reason. If there are two or more children in a family, they are most likely to be allowed to cross the road when they each attain the same age. Where mothers said that one of their children did cross at a younger age than the others, the first-crosser was most likely to be the later-born child. The majority of children own a vehicle of some sort, such as a tricycle, bicycle or wagon. These vehicles are used mainly as toys rather than a means of transport, a fact indicated by the number of children permitted to ride on the roadway at all. Only four children in a sample of approximately 2,000 had cycled to school on the day prior to the interviews, though this low incidence may be because of school rules rather than their parents' reluctance to let them do so. The most common method of getting to school for children under nine was on foot, with most of these having a walk of less than 10 minutes duration. The proportion of children who walk is largely independent of age. However, the older (over 10) children in the sample were less likely than the younger ones to have the company of an adult or a child over 10 years old for the walk to school. Mothers appeared to accept the fact that parents have the main responsibility for teaching children road safety (rather than the schools or police) and most of them had already taught the youngest child (age 2) something about crossing roads, with the complexity of the instructions depending on the age of the child in question.

by Judy Sadler  
Office of Population Censuses and Surveys, Social Survey Div.  
Rept. No. SS450 ; 1972 ; 146p  
Prepared for the Road Res. Lab. in 1969.  
Availability: Her Majesty's Stationery Office, London, L1.15

HS-018 598

### THE ROLE OF OUR LEGAL SYSTEM IN INFLUENCING DRIVER BEHAVIOR

A discussion of the problems and issues of driver behavior as influenced by the four functions of our legal system is presented. Those functions are: law generation, enforcement, adjudication, and sanctioning. It is suggested that the objectives of these functional categories be stated as follows. For law generation, there should be: prescription of behavior that minimizes risk; proscription of behavior that creates risk; and facilitation of the operations of the law system through procedural guidelines, the creation of necessary entities, and the funding of the system. For enforcement, there should be: detection and apprehension of risk-takers for further law system action; manipulation of human behavior to reduce risk-taking; and collection of basic data to identify risk-taking. Re-

garding adjudication, there should be: determination if risk-taking occurred in the case of individuals apprehended by enforcement; determination of the validity of risk proscriptions by law generation; and provisions for the fundamental fairness essential for law system operation. Sanctioning should provide: ultimate system response designed to ensure that the sanctioned individual will not engage in risk-taking in the future (special deterrence); and a pattern of response to individual risk-taking that influences potential risk-takers to refrain from such action (general deterrence).

by Kent B. Joscelyn

Publ: HSRI Research v6 n3 p7-15 (Jan-Feb 1976)  
1976 ; 10refs

Availability: See publication

#### THE 1974 RESTRAINT SYSTEMS: AN EVALUATION

A study was undertaken to analyze and compare crash injuries to occupants wearing lap-torso belts, a lap belt, or no restraint belt. To limit the quantity of accident cases to a number that could be investigated by existing teams, the sampling plan called for investigation of all crashes in which a 1973- or 1974-model car was towed from the scene and an occupant was taken to a hospital, plus a certain percentage of such towaway accidents not involving the removal of an occupant to a hospital. Accidents involving 3,966 vehicles and 5,465 outboard-front-seat occupants were investigated. The basic conclusion to be drawn from the study is that the full-restraint system eliminated more Accident Injury Scale (AIS) greater-than-2 injuries than a lap-belt-only system, and a lap-belt-only system eliminates more AIS greater-than-2 injuries than non-use of restraint. The findings show that the full restraints perform better than the lap belts alone, but not as much better as might have been expected. The question of why the measured performance of the 1974-model restraint system was somewhat disappointing cannot be answered by the data collected in the study. However, part of the answer may stem from the "comfort clip" and other design features of the upper-torso belt in the three-point 1974 model restraint systems. One can assume that some proportion of occupants of crash-involved 1974-model cars were wearing the upper-torso belt adjusted to be so loose that they were deprived of its full protective effect when the crash occurred. If significant numbers of full-restraint users are in fact cancelling the added protective effects of the upper torso belt, the challenge to designers is to develop a full-restraint system that is both comfortable to wear and relatively nondefeatable in its adjustment features.

by Robert E. Scott; Joseph C. Marsh; Jairus D. Flora

Publ: HSRI Research v6 n3 p3-6 (Jan-Feb 1976)  
1976

Availability: See publication

#### HEAVY-DUTY TRUCK SUSPENSIONS

Truck suspensions for heavy-duty trucks perform complex and conflicting functions and have been the subject of much development. Information is provided on several types of suspensions presently in use. These include: front axle; single rear axle; tandem rear axle; auxiliary axles; and installations for use with a single driving axle which include spring, rubber and air suspension types. Applications for which the particular

types of suspension are best suited are described. Wholly or in part, emphasis is placed on leaf spring suspensions, provided on other types which are in current use. Drawings of various suspension components are provided.

by E. R. Sternberg

White Motor Corp.

Rept. No. SAE-SP-402; SAE-760369 ; 1976 ; 55p 23refs

L. Ray Buckendale Lecture No. 22.

Availability: SAE

#### ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE

The brief history of the Otto cycle engine is presented. The dramatic effects that the engine and the vehicles it has produced have had on the way people live are discussed. The economic importance of automotive transportation in the United States and the rest of the world is discussed, as are the relative merits of mass transit and automobiles in moving people.

by H. J. Gibson

Ethyl Corp., Res. Labs.

Rept. No. SAE-760001; SAE-SP-405 ; 1976 ; 17p 2refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976. A Horning Memorial Lecture.

Availability: SAE

#### BICYCLING IN TENNESSEE. INVENTORY OF USERS, FACILITIES, AND PROGRAMS

An inventory report is presented as part of a study of bicycling within the State of Tennessee. Among the principal purposes of this inventory activity are the gathering and synthesizing of information regarding: the existing use of the bicycle; existing special bicycle facility development; and existing governmental programs relating to bicycling within the State. The information is intended to serve principally as a basis for assessing the current situation both in relation to the bicycle user and in relation to governmental bodies that are being called upon to respond to the recent increase in bicycling. Among the topics covered are: the estimated number of bicycles and bicyclists in Tennessee; a profile of bike users by age, sex and socio-economic status; frequency of bicycling by trip purposes (recreation, touring, and transportation); relationship of geographic location to bicycling; the magnitudes of accidents and thievery; public opinion regarding potential recreational bicycling facilities and bicycle facilities; a list of existing and planned bicycling facilities; existing or planned bicycling programs; a description of the perception of need for bicycle facilities and programs; ordinances affecting bicycle facilities and programs; state and federal agency involvement in bikeway construction planning; agency involvement in bikeway funding; bicycling programs; new state and federal legislative action; Tennessee activity in relation to activity in other states; and potential constraints to bicycling. It was found that over one third of Tennesseans are bicyclists, and over half of households own 2.22 bicycles. Half of the bicyclists are under 20, male, and belong to middle-class families. The average bicyclist rides once every three days. Bicycling activity is frequent in small urban areas. There seems to be a

public desire for special recreational facilities which would be typically located in rural areas. In general, Tennessee is neither a leader nor a follower in providing for the bicyclist, but is, in general, keeping up with most other states. Copies of a telephone bicycle user survey and a local governmental survey questionnaire used in the study are appended and a map of Tennessee on which potential bikeway opportunities are plotted is included.

Barton-Aschman Associates, Inc., Ten Cedar Square  
West/Cedar-Riverside, 1610 South Sixth St., Minneapolis,  
Minn. 55404

1974 ; 186p refs

Supported in part by a grant from the Dept. of the Interior,  
Bureau of Outdoor Recreation. Prepared in affiliation with the  
A. C. Nielsen Co.

Availability: Corporate author

HS-018 603

### PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES

Surveys of road curvature, superelevation, gradient, and number and distance from the roadway of roadside hazards were conducted at 300 Georgia sites of fatal crashes into fixed objects and 300 comparison sites one mile away on the road that the vehicle had probably traveled. It was found that more than 26% of fatal crash sites had curvature greater than 6 combined with downhill gradient of 2% or steeper in the roadway at or approaching the sites. Only 8% of comparison sites had such roadway characteristics. Half the fatal crashes occurred at or near curves greater than 6 irrespective of gradient. Only 23% of comparison sites had such curvature and a state study found only 22% of roadways with curvature more than 5.5 throughout the state. Non-local roads accounted for 83% of the fatal crashes into fixed objects but comprised only 33% of the roads in the state. Ninety-eight percent of the objects struck were within 50 feet of the pavement edge. In conclusion, it is recommended that top priority should be given to roadside hazard modification on and near curves greater than 6, particularly those accompanied by downhill grades of 2% or steeper, on non-local roads.

by Paul H. Wright; Leon S. Robertson  
Georgia Inst. of Tech.; Insurance Inst. for Hwy. Safety,  
Watergate Six Hundred, Washington, D. C. 20037  
1976 ; 19p 14refs

Supported by the Insurance Inst. for Hwy. Safety. Prepared in cooperation with the Georgia Dept. of Public Safety and the Georgia Dept. of Transportation.

Availability: Insurance Inst. for Hwy. Safety, Watergate Six Hundred, Washington, D. C. 20037

HS-018 604

### ALCOHOL, DRUGS AND ACCIDENT RISK

An investigation representing a systematic attempt to study the interactive effects of single therapeutic doses of drugs and social doses of alcohol on human sensory, cognitive and motor performance is presented. It was presumed that the information obtained would be of value in predicting the hazards of drug-alcohol involvement in the driving situation. Subjects (college students 18-30 years old) were exposed to doses of alcohol at levels of 0.54, 0.75 and 1.0 grams per kilogram weight (g/kg), which induced peak blood alcohol concentrations

(BAC) of about 0.06%, 0.09% and 0.11% respectively. The effects at each of these levels were found to impair the performance of subjects in a dose-dependent manner. A high dose of alcohol was utilized where antagonism of the drug on effects of alcohol might be expected to occur. The two lower doses, which induced lesser impairment, were used in investigations where either synergism or an additive effect was anticipated. Drug studies were of two types: those which were taken to counteract the inebriate effects of alcohol; and those for which there was clinical evidence of an interactive effect. The interactive effects of fructose and dextrose (1.2 g/kg, orally) and alcohol (1.0 g/kg) were compared in order to determine whether fructose had some special ability to influence the way in which a person handles alcohol. Although slightly lower blood alcohol peaks were attained when fructose and dextrose were taken after alcohol than when alcohol was given alone, this effect was attributed to a delay in gastric emptying. The rate of alcohol metabolism was not affected. The sensory, cognitive, and motor performance of the subjects was not significantly affected. Decaffeinated coffee containing caffeine (300 mg/kg) taken after alcohol (0.75 g/kg) did not induce the "sobering-up" effect which is commonly believed to occur. Caffeine did improve reaction time when this was impaired by alcohol, however. The effects of two antihistamines, dexchlorpheniramine and meclastine, were investigated alone, and in combination with alcohol. Although a general synergistic effect between dexchlorpheniramine and alcohol (0.75 g/kg) was not observed, a delayed recovery from the effects of alcohol occurred in most tests. Meclastine did not significantly modify the effects of alcohol (0.54 g/kg). Tranquillizers were found to have depressant effects on psychomotor performance and significant synergistic interactions occurred with alcohol at two dose levels (.75, and .54 g/kg).

by Richard K. C. Teo

Department of Motor Transport, Traffic Accident Res. Unit,  
New South Wales, Australia  
Rept. No. 4/75 ; 1975 ; 39p 28refs

Based on studies carried out in the Dept. of Pharmacology at the University of Sydney.

Availability: Corporate author

HS-018 605

### SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY, JANUARY THROUGH JUNE, 1971

During the first half of 1971, the Bureau of Motor Carrier Safety field staff inspected 15,230 vehicle units (trucks, highway tractors, trailers, and semitrailers) at roadside check points in all sections of the country. Of those checked, 3,689 units (24.2%) were found to be mechanically unsafe to continue in operation because of serious defects in advanced stages. Each of these units was ordered removed from service, and held at the check point until repairs had restored it to safe operating condition. The 24.2% was a slight increase from 24.0 percent of all units taken out of service in the 1970 checks. In three and a half years, there has been a slow upward trend, and the pattern is listed in tables, along with tables of defects found.

Federal Hwy. Administration, Bureau of Motor Carrier Safety,  
Washington, D. C. 20590

1972 ; 17p

Availability: Corporate author

HS-018 605

HS-018 606

#### **SELECTED SAFETY ROAD CHECKS. MOTOR CARRIERS OF PROPERTY. 1970**

The Bureau of Motor Carrier Safety's field staff inspected 36,842 property-carrying vehicles (trucks, tractors and trailers) during the course of its regular road check program in 1970. Of these, 8,826 (24.0%) were found to be seriously defective in one or more mechanical areas of vital importance to safe operation. The unsafe vehicles were placed out of service at the point of inspection until essential repairs could be completed. The number of defects and out-of-service defects are tabulated.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20591  
1971 ; 15p

Availability: Corporate author

HS-018 607

#### **THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING**

A study is presented examining the influence of forward vision and target size on apparent inter-vehicular spacing. The experiment used color slides to investigate whether two geometrical features of the cars involved in car-following influenced apparent spacing. The two properties investigated were forward obscuration of the following car and target size of the lead car as characterized by one of its linear dimensions. The linear dimension chosen was the length of the rear bumper visible to the following driver. The values for forward obscuration distance depend on the characteristics of the vehicle and the body dimensions of the subject, as well as various random errors of measurement. The results suggest that apparent spacing between cars is not influenced by the target size of the lead car. This could indicate that the size of the image of a lead car on the retina is not the main cue to spacing, although when all other factors remain the same, changes in the size of the image of the lead car could provide a cue to changes in the spacing. Apparent spacing was dependent on the view from the following car, and suggest that an important spacing cue in driving a vehicle is the amount of roadway visible. If the assumption is made that when a driver transfers from a standard-sized car to a small car he attempts to follow at the same following distance, the results presented are consistent with the interpretation that the car that presents the driver with a view of more roadway will be driven at a closer following distance. Specifically, the results presented here indicate that to maintain the same subjective spacing, an automobile exposing three meters more roadway to the driver's view would be driven about one meter closer to the car it was following.

by Leonard Evans; Richard Rothery  
Publ: Transportation Science v10 n1 p85-101 (Feb 1976)  
1976 ; 17refs

Availability: See publication

HS-018 608

#### **SAFETY ROAD CHECKS, MOTOR CARRIER PROPERTY. JULY THROUGH DECEMBER 1972**

Continuing its safety road check program, the Motor Carrier Safety inspected 24,655 property highway units (trucks, tractor and trailers) in the second half of 1972, and placed 5,212 (21.1%) of them out of service because essential repairs could be made. This was a decrease from rates of 23.5 units out of service per 100 inspected in both the first half of 1972 and in the second half of 1971. The last two semiannual road check reports point to a slight decrease in the units out-of-service followed by a decrease in the rate at which out-of-service effects, especially those in service brake application, were reported, suggesting that they appeared to be indicators of a reversal in the trend toward less adequate maintenance. The reversal of a long continued trend of higher proportions of the inspected units being found to be centrally too hazardous to be continued in highway service is a central finding of road check data through 1972. Details relating to the changes since 1966 are tabulated.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20590  
1973 ; 23p

Availability: Corporate author

HS-018 609

#### **SAFETY ROAD CHECKS, MOTOR CARRIER PROPERTY. JANUARY THROUGH JUNE 1973**

A summary is presented of roadside inspections throughout the United States for the first half of 1973, compared with that of the previous 24 months in order to provide estimates on the direction of the industry toward driver and vehicle safety. During the first six months of 1973 the Bureau of Motor Carrier Safety inspected 18,163 units operated by motor carriers of property and food safety defects. Of the units inspected, 3,863 (21.3%) were placed out of service because of the defective condition hazardous to allow continuance of operation. The units selected for inspection composed 9,581 vehicles, 3,348 (34.9%) were rendered unsafe because one or more of the vehicles units were placed out of service. Total units inspected during this time period were 16.2% fewer than the corresponding period of the previous year. The primary reason for this was the greater emphasis placed on hazard analysis, safety surveys and motor carrier safety education. Details of the defects are tabulated.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590  
1974 ; 27p

Availability: Corporate author

HS-018 610

#### **HOW SAFE AT ANY SPEED? A CRITICAL LOOK AT TEN YEARS PROGRESS IN CAR SAFETY**

Ten years after the publication of Ralph Nader's "Any Speed", researchers gathered at the Motor Research Association's Ride and Handling Course to assess the amount of progress which has been seen

decade. Vehicles being tested were a 1965 Chevrolet Corvair and a Leyland Phase 2 Marina Safety Research Vehicle. Dr. Murray Mackay of the University of Birmingham (England) evaluated the vehicles. Comparison revealed that many advances had been made, particularly in the area of vehicle design, including improvements in: steering wheel design; door locks; windshield glass; dashboard configuration; placement of switches and handbrake levers; and instrument panel padding. These comparisons were made from the inadequately designed Chevrolet Corvair to the much improved safety research vehicle. Dr. Murray feels that further research should be carried out to translate present design rules on steering wheel design, door locks, safety belts and seat mountings into more scientific performance standards. Future regulations should reflect the most up-to-date knowledge in the realm of highway safety.

Publ: Auto Car v144 n4138 p8-9, 12 (28 Feb 1976)  
1976

Availability: See publication

HS-018 611

#### **COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN**

A response is made to Zylman's critique of the author's work on the collision behavior of young drivers. Areas where Zylman's remarks were either inconsistent or simply incorrect are pointed out. These can be basically summed up in the following remarks: the question of whether the change in age of majority is responsible for an increase in the incidence of alcohol-related problems, is incorrectly interpreted by Zylman who suggests that the original study attributed any increase in collisions for teenagers to the change in drinking age; a number of factors leading to the increase in alcohol involvement among young drivers were detailed, and subtracted from the over-all effect observed; Zylman's second objection is centered around the analysis of data, but the author contends that the study examined a combination of all types of collisions, not just fatal collisions (which Zylman recommends focusing upon), and he endeavored to draw conclusions which would be a more reliable measurement of the effects of change in the age of a majority, because a data base drawn from fatal crashes only would be too limited; and Zylman has introduced a number of irrelevant perspectives and opinions around the central issues.

by Paul C. Whitehead

Publ: Journal of Studies on Alcohol v37 n3 p402-8 (1976)  
1976 ; 11refs

Availability: See publication

HS-018 612

#### **MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975-- INDIANAPOLIS, INDIANA**

On June 12, 1975 at 5:09 a.m., a tractor trailer combination transporting poultry ran off the road and overturned down the embankment of an interstate highway interchange. Two fatalities resulted from the accident, in which it was determined that the driver of the truck was physically incapacitated as a result of alcohol intoxication (.27% blood alcohol content). The driver was a 37 year old male with 10 years experience in the operation of commercial vehicles. His driving record revealed 9 arrests as a result of reckless driving, driving while intox-

icated, speeding, or driving while his license was suspended. Posted speed at the site of the accident was 55 mph, with a low volume of traffic at the time of the accident, and clear, dry pavement. At the time of the accident, the truck was estimated to be travelling at 50 mph. The other fatality involved in the accident was the driver's 12 year old daughter, believed to have been riding in the passenger seat. The driver's son, who was in the sleeper berth at the time of the accident, sustained moderate injuries. Photographs of the accident scene are provided.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20590  
Rept. No. BMCS-75-5 ; 1975 ; 12p  
Availability: Corporate author

HS-018 613

#### **STRATIFIED CHARGE ENGINES. FINAL REPORT**

Conservation of petroleum resources and the stringent regulations to protect the environment have given strong impetus to the development of stratified charge engines for automotive application. Stratified charge engines are also attractive from the manufacturing viewpoint, since the conventional internal combustion engine, with only minor modifications, can be used to implement most stratified charge concepts. A stratified charge engine is a spark-ignition, internal combustion engine using an overall lean fuel mixture, the mixture nearer the ignition source being the richest. The fuel-rich mixture ignites, and less rich mixtures are, in turn, ignited. Complete combustion of the overall lean mixture, then, is accomplished with greater thermodynamic efficiency than that obtained with homogeneous combustion engines. The stratified charge engine is the only foreseeable alternative to the catalytic converter for emission reduction and shows promise of being effective and economical in the future. Major engine development programs are presently being conducted by Ford, Texaco, and Honda. Vehicles powered by the Ford Programmed Combustion Process (PROCO) and the Texaco Controlled Combustion System (TCCS) engines have demonstrated 25% improvement in fuel economy over 1968 pre-emission controlled engines. Furthermore, PROCO and TCCS have attained fuel economy improvements over comparable 1975 model year, conventional automobiles. Vehicles powered with emission controlled TCCS, PROCO and compound Vortex Controlled Combustion (CVCC) engines show the ability to provide comparable performance to vehicles powered by conventional engines. In the case of a TCCS powered vehicle, a turbocharger is added to increase power. A PROCO powered vehicle would require an estimated 20 to 25 percent larger engine to provide the acceleration performance of a conventional engine. Prototype, low-mileage stratified charge engines, based on TCCS and PROCO concepts, and equipped with catalysts, have demonstrated the ability to meet statutory grams per mile emissions standards of .41 hydrocarbons, 3.4 carbon monoxide, and .4 nitric oxides. Fuel economy deteriorates about 30% when nitric oxide emissions are reduced to .5 grams per mile. Emissions of the CVCC vehicles double as car weight doubles, which indicates that the CVCC concept becomes less desirable in larger automobiles. U.S. automobile manufacturers are non-committal about investigating the concept until government

HS-018 614

specifications for emissions are set. Incremental cost is estimated at \$250 over baseline 1974 prices.

by Eric M. Withjack

Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142

Rept. No. DOT-TSC-OST-75-56 ; 1976 ; 110p 53refs

Report for Oct-Dec 1974.

Availability: NTIS

HS-018 614

## EFFECTS OF STUDDED TIRES

Facts currently available on the effects of studded tires in the United States are presented. Studded tires were first introduced in the U.S. in 1963. The damaging effects of studs on pavements were soon realized, and many states have restricted their usage. Original tire studs consisted of tungsten carbine held in a jacket in the tread rubber by a flange. Newer studs are similar in design but smaller and lighter, with a tapered carbine pin. Performance tests on ice have shown consistently better traction and stopping ability with studded than with un-studded snow tires. Performance tests of studded and un-studded tires on wet and dry pavements, furthermore, indicate increased required stopping distances for studded tires on concrete. New tire designs and devices are under study as possible alternatives to studs, including changes in the components of the rubber allowing the tread to stay soft at low temperatures for better traction on ice; and tire treads impregnated with abrasive materials to give short stopping distances. Pavement wear has received the most attention in the studded-tire debate. Many laboratory studies have revealed increased pavement wear from studded tires which may increase the tendency for hydroplaning in pavements worn away by the effects of studded tires. An economic analysis of studded tires should include the cost of the studs, cost of pavement wear, the benefits of increased mobility, safety benefits and losses, and the costs of alternatives. Various specifications and studded tire regulations for various states (Maryland, Michigan, and Utah) are appended.

Transportation Res. Board, National Res. Council, Washington, D.C.

Rept. No. NCHRP-Synthesis-32 ; 1975 ; 53p 43refs

Research sponsored by the American Assoc. of State Hwy. and Transportation Officials in cooperation with the Federal Hwy. Administration.

Availability: Corporate author

HS-018 615

## COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.

A study was conducted which reported a substantial increase in collisions, especially alcohol-related collisions, among young males in London, Ontario, and attributed this increase to the reduction in the age at which it was legal to purchase beverage alcohol in Ontario. The study was based on the premises: that the working definition of an accident did not change from before to after the change in law; that the policy of recording alcohol involvement in collisions did not change from before to after the change; and, therefore, that any increase in collisions among teenagers after it became legal to purchase alcohol at age 18 can be attributed to the change in law. These premises are discussed and comments are made on the aftermath of the

similar change in the age of majority in Michigan. The results of studies in Toronto, Michigan, and New York, and a national survey, suggest that whether the law sets the minimum alcohol-purchasing age at 21 or at 18 is of little importance. Major changes in social norms are occurring among youth with or without the sanction of the law. It is not only possible but quite probable that the changes in drinking and driving-after-drinking in Michigan and any increase in collision involvement among youth in London, Ontario, would have occurred without the change in the law. It is concluded that the idea that the increase in collisions among young drivers was a result of the change in law, without investigation of the possibility of changes in collision reporting or of changes in drinking practices independent of the change in law, is subject to question.

by Richard Zylman

Publ: Journal of Studies on Alcohol v37 n3 p393-401 (1976) 1976 ; 16refs

Availability: See publication

HS-018 616

## THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES

While the motorcycle has been popular in the United States for more than 10 years, it has been an integral part of European and Australian transportation for far longer. Studies of research in England and Australia show that the risk of fatality in a motorcycle accident is reduced by wearing a helmet, based on experiences before and after implementation of helmet-use laws. Research from two Minnesota hospitals in 1963 showed the major causes of deaths to motorcyclists were skull fracture and brain damage. In response to the National Highway Traffic Safety Administration suggestions to include a motorcycle safety standard as one of the initial 13 Highway Safety Program Standards, requiring motorcycle operators and passengers to wear protective helmets, 47 states passed mandatory helmet use laws since 1967. Tables included in the article show the decline of the ratio of fatalities per 10,000 registered motorcycles from 1964 to 1973; serious and non-serious head injury rates according to helmet use; standardized percentage of head injury rates for motorcycle riders; and helmet use and head injury before and after mandatory helmet use legislation in Australia. The remainder of the article presents facts to show that motorcycle helmets reduce incidence of head injuries when used; that helmets do not place undesirable restrictions on the rider, nor increase the chance of neck injury; and that mandatory helmet use laws do reduce the number of serious injuries and fatalities resulting from motorcycle accidents.

by Penelope Johnson; Paul Levy; Robert Voas

Publ: Traffic Safety v76 n4 p9, 11, 30-1 (Apr 1976) 1976

For full report, see HS-801 836.

Availability: See publication

HS-018 617

## THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE

An evaluation of the dangers associated with mandatory helmet-wearing laws is presented, whereby it is advocated that the helmet-wearing decision be taken out of the hands of the

state and federal offices. It is pointed out that most states enacted helmetwearing laws under a threat from the Department of Transportation to withhold funds. Motorcyclists who have taken their case before state legislative committees and courts have seen the failure of the helmet repeal bills due to this fear of losing funds. It is pointed that the record of motorcyclists has been excellent, without government interference, and the fatality trend has been going down for the last 25 years. Lack of training for new motorcyclists is a problem, and it is recommended that training for new riders should be available, preferably in high schools, along with auto driver training. It is argued that helmets produce a decrease in hearing ability and sound directional sense, as well as causing vision and other discomforts that distract the driver. There is also some indication that helmets can cause broken necks. For effective protection, a helmet would have to be custom designed for the individual, and would be unwearable from the rider's standpoint. Expense would be a big factor in this case. Another factor which should be considered for safer motorcycling is more diligent highway maintenance to eliminate poor road surfaces, oil slicks and the like, which can be dangerous to the motorcyclist.

by Ed Armstrong  
Publ: Traffic Safety v76 n4 p9-10, 31-4 (Apr 1976)  
1976

Availability: See publication

HS-018 618

### DRINKING AND DRIVING IN OTHER LANDS

Highway safety problems, which have faced the United States for a number of years, are now facing a growing number of affluent nations of the world. Nations that have traditionally done little or nothing to control traffic crashes are showing a sudden interest in doing something about them. Organizations such as the Organization for Economic Cooperation and Development (OECD) now have special committees studying the problems from several points. The influence of the Road Safety Act of Great Britain, passed in 1967, as regards the alcohol component, is substantial. Nearly all the new legislation passed or being passed in most nations or states of the world is based on it. The law provides for mandatory roadside screening tests to be followed by blood tests. One of the significant developments during the last year has been the sudden interest in evidentiary breath tests by nations that scorned them a short time ago. The chief countermeasure depended upon by every nation reporting was law and law enforcement, followed by public information.

by Robert F. Borkenstein  
Publ: Traffic Safety v76 n4 p20-2 (Apr 1976)  
1976

Availability: See publication

HS-018 619

### UNDER THE INFLUENCE

The incidence and severity of alcohol use and abuse in a population of persons arrested in Philadelphia, Pennsylvania, for the first time for driving while intoxicated is investigated. Two principal sources of data were used: a client intake form, which consisted of an eight-page interview form administered upon arrest; and a home interview form. The method of analysis used to determine whether alcohol impairment was related

to other variables was the chi-square statistical test. When categorized by level of alcohol impairment, the sample of 1,500 first offenders arrested clearly demonstrated that a substantial percentage (54.4%) had a constant, regular abuse of alcohol. Persons under 40 years of age were more impaired than those over 40. The highest percentage of drinking took place between the ages of 20 and 24 years. About 19.4% of the population admitted to the use of some type of controlled drug some time in the three month period preceding arrest. Blacks comprised 49.5% of the sample, whites 47.4%. More than half (53.5%) of the sample population was married. The mean annual income for the sample was \$8,519.

by Eric W. Fine; Pascal Scoles; Michael Mulligan  
Publ: Public Health Reports v90 n5 p424-9 (Sept/Oct 1975)  
1975 ; 24refs

Availability: See publication; Eric W. Fine, West Philadelphia Community Mental Health Consortium, P.O. Box 8076, Philadelphia, Pa. 19101

HS-018 620

### REEDUCATION AND REHABILITATION OF THE DRUNKEN DRIVER

It has long been recognized that drunken driving (DWI) is a disproportionately large contributor to highway accidents and fatalities. Practical and effective programs should be designed to reduce the problem of DWI. One approach is a corrective course for persons convicted of DWI, and it has shown promise not only for reducing driving while intoxicated, but also for dealing with the more pervasive problem of alcoholism. The approach is described, and efforts to evaluate it are presented. Guidelines for identification and help for problem drinkers are investigated. The course was developed in Arizona and is called DWI Phoenix, and has served as a prototype for some 400 courses across the nation. Most DWI corrective courses collect data from records and participants. The battery should include a DWI knowledge inventory, a DWI attitude scale, an alcoholism screening test, selected personal data and official records of the Motor Vehicle agencies concerning alcohol-related convictions. The purpose of DWI corrective courses is to have the participant develop insight into his own drinking and driving behavior and to change it as appropriate for him. Also, counselors trained in alcoholism should attempt to identify problem drinkers among participants and refer those participants as warranted to separate rehabilitation programs. Some DWI corrective programs require those judged to be alcoholics to undergo treatment before the restoration of the driving privilege. Agencies should have a multi-referral capacity, so that the DWI's problems--vocational, family, emotional, financial--can be dealt with centrally.

by James L. Malfetti  
Publ: Journal of Drug Issues v5 n3 p255-69 (Summer 1975)  
1975 ; 23refs

Availability: See publication; James L. Malfetti, Dept. of Health Education, P.O. Box 114, Teacher's College, Columbia University, New York, N.Y. 10027

HS-018 620

HS-018 621

### BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION

By 1920, assembly line production techniques and arrangements of installment purchase had put the automobile within reach of the ordinary working man. Traffic densities increased and deaths in automotive accidents became commonplace. It was soon recognized that many crashes were alcoholic beverage-related and a number of states placed statutory restrictions on the right to drive while under the influence. Effective prosecution for drunken driving then came to require statutory definition of a concentration of ethanol in body fluid at which driving ability became impaired. Technology has advanced since that time, and testing of intoxication levels has moved from blood samples to breath-analysis. The various instruments used since the 1930's to analyze alcohol concentration by the use of breath tests are described, and listed in a table. The blood/breath correlations, found in 28 studies with nine breath testing instruments are also described. Many studies have been performed to determine the accuracy of breath tests, and various forensic and technical problems associated with these studies are discussed. These problems include: variance in the effects of ethanol on assessable nervous system functions; the fact that the physiology and chemistry of breath testing are complex, and leave room for argument in a court of law; questions about the training and certification of operators of breath-testing devices; questions about the reagents employed in on-the-spot breath tests, and whether or not they should be retained for possible admission in court cases; and the fact that there is considerable conflict in data, originating from competent sources, which show frequent, unacceptable discrepancies between the results of analysis for ethanol and blood and breath samples. Each of these points is looked at separately in order to determine some means for establishing accuracy and precision in the use of breath-analysis and accident prevention.

by M. F. Mason; K. M. Dubowski

Publ: Journal of Forensic Sciences v21 n1 p9-41 (Jan 1976)  
1976 ; 159refs

Availability: See publication

HS-018 622

### THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL

A staged combustion engine (SCCE) has been evaluated in which pairs of cylinders are coupled in series. The first cylinder of the pair inducts and burns a homogeneous fuel-rich mixture which produces exhaust products containing substantial amounts of the following combustibles: carbon monoxide, hydrogen, and hydrocarbons, and only small quantities of nitrous oxides. These products are then cooled, mixed with additional air, and inducted into another cylinder for a second stage of combustion. Additional work is extracted in this stage, where substantial cleanup of carbon monoxides and hydrocarbons occurs, while maintaining the low level of nitrous oxides. Experiments with a two-cylinder research engine showed that low nitrous oxide emissions could be obtained without sacrificing engine efficiency. However, approximately 40% more displacement is required to produce the same power as conventional spark ignition engines. The

sources of hydrocarbons, carbon monoxide, and nitrous oxide emissions were investigated, as were the effects of major engine variables on these exhaust emissions and fuel consumption. The staged combustion concept was implemented using a 7.46 liter V-8 engine, for which the necessary control systems were devised and built. This engine was evaluated in an experimental vehicle on a chassis dynamometer with a 2041 kilogram inertia weight. Present Federal Test Procedure (FTP) emission levels are 0.87 grams per mile (g/mi) hydrocarbons; 8.7 g/mi carbon monoxide; and 0.34 g/mi nitrous oxide at low mileage using a catalytic converter. FTP fuel economy is 11.5 miles per gallon, but acceleration performance is poorer than comparable production cars. Adequate evaluations of production-related factors such as driveability, durability, and fuel requirements have not been made. Although the low nitrous oxide emission demonstrated by the engine concept is noteworthy, the engine is presently precluded from serious contention by the stringent limitations which current statutes place on allowable hydrocarbon and carbon monoxide emissions during the 1975 FTP.

by Robert M. Siewert; Stephen R. Turns  
General Motors, Res. Labs.

Rept. No. SAE-750889 ; 1975 ; 24p 20refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.

Availability: SAE

HS-018 623

### WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION

It is author's opinion that the highway casualty epidemic is almost unique as a national problem that has responded to public policy actions. The death rate per 100 million vehicle miles has declined from 5.7 in 1966 to 3.5 in 1975. However, the author contends that much more could have been accomplished without interference from the White House and obstruction by the automobile industry. The author cites inaction and delay by the National Highway Traffic Safety Administration (NHTSA) as indicative of deficiencies in the regulatory environment and lack of backing from the White House. Examples of auto industry actions which are counterproductive of vehicle safety are discussed, particularly the industry's view that the cost of safety related features will cut car sales. The NHTSA is criticized for delay in implementing present standards and promulgating new ones, its handling of defect and recall problems, its failure to pursue the experimental safety vehicle program vigorously and utilize its technological advances, its inaction on the airbag and other passive restraints, and its failure to regulate the tire industry. Legislation on and industry response to emission controls are also criticized, and the failure to develop alternatives to the internal combustion engine is given as an example of auto industry monopolistic practices.

by Ralph Nader  
1976 ; 51p 36refs

Marked "For Release-Monday, AMs Feb. 23, 1976."

Availability: Center for auto safety, 1223 Dupont Circle Bldg., Washington, D. C. 20036

HS-018 624

## EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE

The effect of the motor vehicle control program on ambient hydrocarbon concentrations in a metropolitan area during peak traffic hours is investigated. Data was obtained from gas chromatographic analyses of Los Angeles air samples taken in 1963-65, before implementation of the exhaust control program for new motor vehicles, and in 1971 and 1973, after several years' application of this program. A brief history of the motor vehicle program in California together with emission standards for hydrocarbons are discussed and certain automobile-related hydrocarbons are identified and characterized. Frequency distributions were constructed for total hydrocarbons, non-methane hydrocarbons, methane, acetylene, and isopentane for 1963-65, 1971, and 1973 and the standard deviation concentration limits are discussed for each of the subgroups mentioned above. The average concentration and relative percent comparisons for methane, ethane, n-butane, isopentane, C3 plus paraffin, ethene, propene, C4 plus olefin, acetylene, benzene, and toluene are shown and discussed in detail. These studies show hydrocarbon emissions from motor vehicles were reduced 47.6% during this time period; indicate selective reduction of compounds; and reveal a 51.8% reduction in the 1973 ambient total hydrocarbon concentration since 1963-65.

by M. J. Leonard; E. L. Fisher; M. F. Brunelle; J. E.

Dickinson

Publ: Journal of the Air Pollution Control Association v26 n4 p359-63 (Apr 1976)  
1976 ; 6refs

Presented as paper no. 75-754.3 at the 68th Annual Meeting of the Air Pollution Control Association, Boston, June 1975.

Availability: See publication

HS-018 625

## BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE

The results of a search made during the spring of 1974 for systematic information on blood alcohol concentration (BAC) among drivers in Norway, Sweden, Denmark, and Finland are reported. The search was made in these countries for studies performed on random or representative samples of: drivers fatally injured in crashes; drivers seriously injured in crashes; and drivers not involved in crashes. Only one study, limited to the city of Oslo, Norway, was found of drivers not involved in crashes. Sweden and Denmark have produced a scattering of broader but still incomplete studies of fatally injured drivers. A very few small-scale studies of seriously injured drivers were found in Sweden and Norway. Finland has produced no systematic studies on these topics. The studies of fatally injured drivers suggest that elevated BAC's are less common in Sweden and Denmark than in the United States. The single study of drivers not involved in crashes finds an extremely low prevalence of BAC's. However, the studies of injured drivers are not completely in accord with the picture based on the other populations. Alcohol may be less prominent in motor vehicle crashes in Scandinavian countries than in many other

countries but the causes of this phenomenon cannot be determined without further information.

by H. Laurence Ross

Publ: Blutalkohol v12 n6 p372-81 (Nov 1975)  
1975 ; 20refs

Supported by the Insurance Inst. for Hwy. Safety,  
Washington, D. C.

Availability: See publication

HS-018 626

## ALTERNATIVE POWER SOURCES FOR LOW EMISSION AUTOMOBILES

The possibility that an alternative engine might replace the spark-ignition (SI) gasoline-fueled type over the next 20 years is considered. The gas turbine, the steam, the Stirling, and the electric engine are compared to typical gasoline SI engines in terms of: emissions, fuel versatility, fuel consumption, noise, safety, cost, starting ease, tolerance to abuse and neglect, driveability, serviceability, design horsepower versatility, control ease, producibility, size, weight, integrability, present production status, earliest limited production, and earliest mass production. It is concluded that no alternative engines would be available for mass production in standard size and performance before the 1980's, and although some alternative engines may become competitive over the next two decades, the SI type will probably still be around at that time.

Publ: Automotive Engineering v83 n10 p64-7 (Oct 1975)  
1975

Based on SAE-750929 "An Evaluation of Alternative Power Sources for Low-Emission Automobiles" presented at the Automobile Engineering and Manufacturing Meeting, Detroit, 13-17 Oct.

Availability: See publication

HS-018 627

## WHY TRAFFIC CONTROL IS A MUST×

The need for the continuation of a 55 mph speed limit is stressed in a discussion of speed control. The fuel savings and fatality reductions attributed to the 55 mph limit instituted during the 1973-74 energy crisis are discussed, reactions to speed limit enforcement are related, and some of the history of speed control and "speed traps" is given.

by William L. Roper

Publ: California Highway Patrolman v39 n8 p23-25, 28-29, 32-3, (Oct 1975)

1975

Availability: See publication

HS-018 628

## HANDLING YOUR CAR ON ICE AND SNOW

Suggestions regarding automobile handling in ice and snow conditions are offered. Methods of braking, reacting to skids and other vehicle adjustments to winter driving conditions are briefly discussed.

by Curtis W. Casewit

Publ: California Highway Patrolman v39 n9 p21, 67, 73-4 (Nov 1975)

1975

Availability: See publication

**AN INVESTIGATION TO DETERMINE WHETHER  
BLOOD ALCOHOL TESTS SHOULD BE  
COMPULSORY FOR ALL TRAFFIC ACCIDENT  
CASUALTIES OVER THE AGE OF 15 YEARS  
ADMITTED TO HOSPITAL IN WESTERN  
AUSTRALIA**

It was found to be very desirable for medical practitioners to know the blood alcohol content (BAC) of traffic accident casualties admitted to their care. An investigation was conducted to determine whether BAC tests should be compulsory for all such casualties over the age of 15 admitted to a Western Australian hospital. Regarding the law enforcement point of view, it was estimated that 440 injured, or claiming to be injured, drivers escaped apprehension for their drinking-driving misdemeanors in Western Australia in 1973, because they were admitted to a hospital following the accident. Compulsory BAC tests in the hospital should have a deterrent effect in addition to correcting the above evasion of the law. The problem is discussed from a medico-legal, a statistical and research, a civil liberties, and a driver rehabilitation viewpoint. It is concluded that the arguments used to oppose the introduction of the tests do by no means counteract the arguments in favor. The introduction of the compulsory hospital BAC tests is recommended

by D. I. Smith  
Road Traffic Authority, Res. and Statistics Section, 22 Mount  
St., Perth, W.A. 6000 Australia  
1975 ; 49p 144refs  
Availability: Corporate author

**AN INVESTIGATION TO DETERMINE WHETHER  
THE DAYTIME USAGE OF MOTORCYCLE  
HEADLIGHTS AND TAILLIGHTS SHOULD BE  
MADE COMPULSORY IN WESTERN AUSTRALIA**

A review of Australian and other literature was made and it indicated that lack of daytime visibility of motorcyclists to other road users could be a contributing factor of some importance to the incidence of motorcycle accidents. Compulsory daytime headlamp and taillamp usage by motorcyclists was found to reduce motorcycle accidents in four American States by 4.4%. An analysis of the various driving errors which led to motorcycle accidents in Western Australia during 1973 indicated that a similar, or possibly an even greater reduction, could be expected in this State. Various alternative methods for increasing daytime motorcycle visibility were considered, but were found to be inferior to the use of the lamps. Two surveys were made of the incidence of voluntary daytime motorcycle headlamp usage in the metropolitan area of Perth, Australia. Both surveys were five one-hour counts at five different locations. It was found that only 43% of the motorcyclists observed in the first survey (spring 1974), and 35% in the second survey (spring 1975), had their headlamps "on." Investigations concluded with the strong recommendation that the compulsory daytime usage of motorcycle and motorscooter headlamps and taillamps should be introduced at an early date.

by D. I. Smith  
Road Traffic Authority, Res. and Statistics Section, 22 Mount  
St., Perth, W.A. 6000 Australia  
1975 ; 35p 51refs  
Availability: Corporate author

**AUTOMOTIVE DIAGNOSTIC AND REPAIR  
EQUIPMENT**

The markets for automotive diagnostic and repair equipment in the United Kingdom (U.K.) are analyzed, and the opportunities available to exports from the United States (U.S.) are assessed. Garages catering to private motorists and private car dealers account for about 70% of total garage equipment bought. Public transportation authorities (owners of bus lines) and commercial vehicles (trucks) account for the remaining 30%. The garages serving private motorists are decreasing in number but increasing in the sizes of the units. High gasoline costs are making motorists more sensitive to engine performance. High wage costs and labor recruitment problems are aiding automation. The market for automotive equipment is growing and a slower but steadier demand for such equipment comes from the commercial vehicle sector. Key factors in the structure of the market are: the influence of the Ministry of the Environment on required standards of equipment for testing the roadworthiness of vehicles; the influence of big oil companies through gasoline station franchises on the choice of equipment bought by garages; about 80% of garage equipment is sold through a small number of influential wholesalers; and in most product areas competition is keen and imports small because foreign companies (including those in the U.S.) operate mainly through U.K. based subsidiaries. The main product categories in descending order of importance in terms of opportunities for U.S. companies are as follows: brake testing equipment; exhaust emission testing equipment; engine diagnostic equipment; lifts and hoists; portable jacks; and presses.

Peter Ward Associates (Interplan) Ltd., 9-15 London Rd.,  
Croydon, CRO 2RE England  
Rept. No. DIB-75-12-507 ; 1975 ; 44p  
Availability: NTIS

**INTER-INDUSTRY EMISSION CONTROL PROGRAM  
2 (IIEC-2) PROGRAM REPORT NO. 2**

Reports on the following aspects of emissions control are presented: the octane requirements of today's vehicles; data on octane requirement variables; performance characteristics of stratified charge vehicles with conventional fuels and gasoline blended with alcohol and water; the effects of engine variables and exhaust gas recirculation on emissions, fuel economy and knock; oxides of nitrogen catalytic converter development; a study of ammonia formation and its control in the oxides of nitrogen catalyst system; laboratory evaluation of three-way catalysts; and a characterization of Zirconia and Titania engine exhaust gas sensors for air/fuel feedback control systems.

Society of Automotive Engineers, Inc., 400 Commonwealth  
Drive, Warrendale, Pa. 15096  
Rept. No. SAE-SP-403 ; 1976 ; 55p refs  
Includes HS-018 633--HS-018 640.  
Availability: SAE

HS-018 633

## ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES

Studies with cars and full scale engines in the laboratory have provided additional information on the parameters which affect octane requirement increase (ORI) in today's automobiles. Octane requirements were determined by the use of full boiling range reference fuels (FBRU) and primary reference fuels (PRF). Requirements of eight 1973 cars of two makes, and three 1973 car pairs were measured in road tests of 40,000 miles for each car. Combustion chamber volumes of the automobile pairs and of laboratory engines were measured by the Whistle method. Tests showed that ORI with unleaded gasolines was about two units higher than with leaded gasolines and that coolant system degradation had little or no effect. Studies in the laboratory showed that oil consumption rate, oil multi-grade range, fuel detergent additives, and coolant temperature all affected ORI to some degree. Oil ash level and a manganese antiknock additive had no effect. Combustion chamber deposit studies showed that a good correlation existed between ORI and the ratio of carbon to metals in the deposits. This correlation suggests that the carbon to metals ratio should be minimized to reduce ORI. Additional studies are needed to confirm the results and to further define the parameters which must be controlled to minimize ORI.

by B. D. Keller; G. H. Meguerian; C. B. Tracy; J. B. Smith  
Amoco Oil Co.

Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2), Program Report No. 2, Warrendale, Pa., 1976, p1-8.  
Rept. No. SAE-760195 ; 1976 ; 15refs  
Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: In HS-018 632

HS-018 634

## MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES

The effects of selected fuel additives, engine operating conditions, and driving modes on octane requirement increase (ORI) were investigated for the 1975 Ford 400 cubic inch diameter (CID) engines. The total program consisted of 27 Ford 1975 LTD's equipped with 400 CID engines, automatic transmissions, air conditioning, catalysts, and the same 49 state emission packages. The total program was divided into a nine car fleet and an eighteen car fleet. The nine car fleet underwent mileage accumulation for three months, while the 18 car fleet underwent different testing for three months. Three of the engines in the 18 car fleet were modified to operate at lower temperatures. It was found that the reduced coolant temperatures significantly lowered ORI. Methanol also reduced ORI. Six different fuels were used in the research. These were blended to give distinctly different distillation behaviors. It was found that an inverse relationship existed between initial octane requirements and ORI, which could be detected only under rigid experimental conditions. The direct relationship previously reported between heavy fuels and ORI was not confirmed. A trend to increase ORI when a fuel contains a carrier oil or a slightly elevated air/fuel ratio was suggested.

The ORI difference between two driving modes was indeterminate, but the driving modes may influence the rate of ORI.

by R. B. Saillant; F. J. Pedrys; H. E. Kidder  
Ford Motor Co., Engineering and Res. Staff  
Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2), Program Report No. 2, Warrendale, Pa., 1976, p9-16  
Rept. No. SAE-760196 ; 1976 ; 10refs  
Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: In HS-018 632

HS-018 635

## PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

The effects of fuel volatility and alcohol content on vehicular performance were determined in unmodified conventional, prechamber stratified charge, and direct injection open-chamber stratified charge vehicles. A clear water-gasoline emulsion fuel was included in the test sequence. The test fleet consisted of three vehicles: a conventionally powered full-size Ford (1974) equipped with air conditioning, automatic transmission and a 400 cubic inch diameter (CID) V engine calibrated to the 1974 49-state emission standards; a Honda Civic equipped with a 4-speed manual transmission and a 1.5 liter prechamber stratified charge engine calibrated to meet the 1975 statutory emission standards; and a 1973 Mercury Montego equipped with a 400 CID engine with a direct fuel injection, open-chamber stratified charge with intake air throttling. Driveability testing of the vehicles was conducted on a chassis dynamometer. During chassis dynamometer testing, the stratified charge vehicles gave generally better driveability than the conventional engine with the base fuel series, and also proved to be insensitive to base fuel volatility. In both the Ford and Honda, driveability demerits decreased in nearly linear fashion with alcohol concentration. Testing on the water-gasoline emulsion showed driveability was unsatisfactory in vehicles powered with conventional and pre-chamber stratified charge engines but marginally acceptable in the open-chamber stratified charge engine. Increasing alcohol content up to 20% increased mass emissions of the open chamber stratified charge engine, reduced emissions of the prechamber stratified charge engine, and had no significant effect on the conventional engine. Fuel economy on an energy utilization basis was improved with increasing alcohol content and reduced with the water-gasoline emulsion.

by K. L. Boekhaus; L. C. Copeland  
Atlantic Richfield Co.  
Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2), Program Report No. 2, Warrendale, Pa., 1976, p17-26  
Rept. No. SAE-760197 ; 1976 ; 7refs  
Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: In HS-018 632

## THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

A study was conducted to investigate the relative importance of engine variables and exhaust gas recirculation for exhaust emission control and the related effects on emissions, fuel economy, and octane number for trace knock. Steady-state data was obtained from a 400 cubic inch diameter (CID) V-8 conventional engine at one speed/load/compression ratio combination. The effects showed engine emission constraints on fuel consumption and octane number for trace knock. The important trends shown by these results were varied: various calibration combinations of air/fuel (A/F) ratio, exhaust gas recirculation (EGR), and spark retard could be used to control the oxides of nitrogen (NOx) emissions; a substantial reduction in NOx emissions was achieved by using EGR and optimized spark timing without suffering a fuel economy penalty, but hydrocarbon (HC) emissions tended to be high; when both HC and NOx emissions were reduced by optimal adjustments of EGR and spark timing, fuel consumption was increased, but octane number for trace knock was decreased; at controlled NOx emission levels, the lowest HC emissions were obtained at A/F ratios of 16 to 18:1; the minimum achievable HC emission level increased with decreasing NOx emissions; injection of secondary air at the exhaust ports generally decreased HC emissions at A/F ratios richer than stoichiometric when the engine exhaust temperatures were greater than 1100 F; and use of secondary air at lean A/F ratios increased HC emissions. In general, through the use of the basic engine parameters investigated, the substantial reduction in engine emissions of HC and NOx was associated with a fuel consumption penalty and with a reduction in the octane number for trace knock measured under the emission test conditions.

by C. R. Morgan; S. S. Hetrick

Mobil R and D Corp.

Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission

Control Program 2 (IIEC-2). Program Report No. 2,

Warrendale, Pa., 1976, p27-34

Rept. No. SAE-760198 ; 1976 ; 9refs

Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: In HS-018 632

## NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT

The ammonia forming characteristics of two oxides of nitrogen (NOx) catalysts were thoroughly studied under steady-state conditions after defining the ranges of such parameters as intake air flow, inlet gas temperature, inlet exhaust emissions and inlet carbon monoxide/oxygen (CO/O2) under the constant volume sampling (CVS)-III (hot) mode. A four-cylinder 1.6 liter engine equipped with a dual-bed catalytic converter system was used. Two catalysts having the same catalytic materials and loadings were prepared on pelleted and monolithic supports. The test results showed that there was no substantial difference in the behavior of the two catalysts except for a small difference in peak ammonia formation at low CO/O2 ratios. A peak ammonia formation existed in the plane defined by the inlet gas temperature and intake air flow. This peak stayed at a specific intake flow rate of about 70 to 80 cubic meters per hour irrespective of CO/O2 ratios. Maximum

ammonia formation at the peak island drops as the CO/O2 ratio is decreased by addition of bleed air because the inlet CO concentration is reduced considerably. It can be concluded that the bleed air addition is effective in reducing ammonia formation on NOx catalysts and in improving net NOx reduction efficiency of the system under CVS-III (hot) mode because it pushes the area of maximum ammonia formation out of the CVS-III (hot) domain and lowers the inlet CO concentration. Test results with catalysts having different volumes and lengths show that ammonia formation goes through a maximum with increased length of catalyst at low intake air flows. The results of the study suggest that the air bleed system could be further improved by effectively controlling the orifice area ratio.

by Y. Kaneko; T. Ohinouye; H. Kobayashi; S. Abe

Mitsubishi Motors Corp. (Japan)

Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2). Program Report No. 2, Warrendale, Pa., 1976, p35-40

Rept. No. SAE-760199 ; 1976 ; 2refs

Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: In HS-018 632

## STUDY OF NH3 (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM

Suppression of ammonia formation over oxides of nitrogen (NOx) catalysts has received limited coverage relating to the effects of modifications of both feed gas conditions and catalyst usage. Ammonia formation has been investigated as a function of such feed gas boundary conditions as carbon monoxide (CO) concentration, carbon monoxide/oxygen (CO/O2) ratio, space velocity, linear velocity and catalyst bed temperature. Both fresh and aged NOx catalysts were used. A Datsun, 4 cylinder, 2 liter engine was employed in the testing procedures. Longitudinal patterns of ammonia formation in monolithic NOx catalysts were also determined. Based upon these results, several ideas were tested to reduce ammonia formation in the NOx catalyst through control of feed hydrogen, CO, and hydrocarbon (HC) concentrations. Finally, the possibility of extending the optimum air/fuel (A/F) range of a catalyst toward A/F ratios by the introduction of methane ahead of the NOx catalyst was explored. The boundary conditions for ammonia formation of both fresh and aged NOx catalysts were determined as function of inlet CO concentration, and inlet gas temperature. The effect of space velocity on ammonia formation did not show any specific tendency. However, ammonia formation depended on feed gas temperature and CO concentration. Ammonia formation tended to decrease with mileage accumulation, and at low linear gas velocities, formation was lower than at high linear gas velocities as inlet CO concentration was increased. Ammonia formation pattern along the axis of a monolithic NOx catalyst was investigated by segment analysis and it was found that at CO/O2 ratios of 2 and higher, most ammonia formation occurred in the front half of the catalyst while the rear half had very little effect. One possible approach to reducing ammonia formation is selective oxidation of hydrogen in the feed gas by the use of a thermal reactor. However, results show that there is no significant effect. It was found that at the same NO conversion efficiency, methane injection formed less ammonia than CO injection. It

is concluded that CO has a predominant effect on ammonia formation in NO<sub>x</sub> catalysts.

by Hiroshi Kuroda; Yasuo Nakajima; Tsuneaki Saito; Takeji Oguri; Tadashi Nagai

Nissan Motor Co., Ltd. (Japan)

Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2). Program Report No. 2, Warrendale, Pa., 1976, p41-53

Rept. No. SAE-760200 ; 1976 ; 5refs

Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: In HS-018 632

HS-018 639

### LABORATORY EVALUATION OF THREE-WAY CATALYSTS

A comprehensive laboratory evaluation was conducted on recent three-way catalyst formulations. Evaluations of selectivity characteristics were made in a synthetic exhaust mixture where "window" widths and positions for three-way conversion and their change after durability runs were determined. Durability runs were made in combusted gases from laboratory pulse-flame exhaust generators using both contaminant-free fuel and fuels with 1975 levels of lead, phosphorus and sulfur. A further examination of the "oxygen storage" capability of the catalysts was performed and results correlated with engine dynamometer experiments designed to utilize the property of three-way catalysts to allow a wider air/fuel (A/F) ratio tolerance. A technique involving intentional modulation of the A/F ratio was found to extend the usefulness of such catalysts. There are multiple possibilities indicated in the integration of three-way catalysts into the overall exhaust emission control system. The system would consist of a fuel metering device, a control module and the catalyst itself. By proper design of the catalyst, the demands on the other two subsystems can be relaxed substantially. Thus, properly utilizing the "oxygen storage" properties, improved carburetors could be used instead of the more costly fuel injection.

by H. S. Gandhi; A. G. Piken; M. Shelef; R. G. Delosh  
Ford Motor Co.

Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2). Program Report No. 2, Warrendale, Pa., 1976, p55-66

Rept. No. SAE-760201 ; 1976 ; 18refs

Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: In HS-018 632

HS-018 640

### CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

Two types of exhaust sensors (zirconia and titania) were studied from the point of view of applying them in feedback systems to control the air/fuel (A/F) operating point of automotive engines. Both sensors were without built-in heaters and designed to indicate when engine A/F passes through stoichiometry. Results were obtained both from engine dynamometers and test vehicles; and from laboratory tests specifically designed to establish advantages or limitations of a specific sensor and associated circuitry. Calibration data were measured for the zirconia sensors in order to plot curves of

sensor output voltage versus A/F with temperature as a parameter. The zirconia sensor was found to be especially sensitive to the presence of hydrogen in exhaust gas. Data establishing this sensitivity is included. Transient response capabilities of the zirconia sensor yielded experimental results pointing to a structural transformation in the sensor. Experiments similar to those for the zirconia sensors were carried out for titania sensors. Calibration data for resistance as a function of A/F with temperature as a parameter are included. The two effects observed in the titania sensors in laboratory tests, were: transition through stoichiometry hysteresis; and rich end point drift. Since both types of sensors and their associated circuitry are in a continuing process of development, basic importance is attached to the measurement techniques and the general types of information developed rather than to the experimental results obtained for either particular sensor at the present time.

by A. L. Cederquist; E. F. Gibbons; A. H. Meitzler

Ford Motor Co., Engineering and Res. Staff  
Publ: HS-018 632 (SAE-SP-403), Inter-Industry Emission Control Program 2 (IIEC-2). Program Report No. 2, Warrendale, Pa., 1976, p67-80

Rept. No. SAE-760202 ; 1976 ; 24refs

Presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: In HS-018 632

HS-801 848

### MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS

Letters of notification and other communications to dealers and their customers regarding possible defects in vehicles produced by domestic and foreign manufacturers are presented without commentary.

National Hwy. Traffic Safety Administration, Washington, D. C. 20590  
1976 ; 501p

Availability: NTIS

HS-801 877

### AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

The operation of the Los Angeles, California, Alcohol Safety Action Project (ASAP) system is reviewed. Activities for 1974 in the following countermeasure areas are summarized: law enforcement; judicial; rehabilitation; licensing; legislation; and public information. Comparisons of crash measures were made using a mini-ASAP area where all countermeasure activities were operative and a control area. Only one of 11 crash measures tested, "single vehicle crashes," gave evidence that there was a statistically significant difference in the two areas for the operational period. Contrary to expectations, there was a lower average number of crashes in the control area than in the mini-ASAP area. Profiles of fatally injured drivers, persons arrested on drunken driving charges (DUI), and a group of average nighttime drivers, as to their blood alcohol concentration (BAC) levels, are provided. Statistically significant results could be obtained only for the group of arrestees. Prior DUI's were positively related to BAC, meaning that the more

HS-801 878

DUI priors an arrestee had, the more likely he was to have a high BAC level. Prior accidents were negatively related to BAC, meaning that arrestees with high BAC levels were less likely to be involved in accidents than persons with lower BAC levels. It is concluded that the study shows little ASAP impact on accident reduction. However, the Los Angeles ASAP is seen as very effective and successful for the following reasons: arrest rates have increased; the ASAP system has provided a method for early detection of drinking problems; and ASAP has provided a model for more effective detection and identification of DUI's.

by Ronald M. Floredo  
County of Los Angeles Alcohol Safety Action Proj.  
Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
1975 ; 115p

Availability: Reference copy only

HS-801 878

#### **AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

A survey was conducted of Los Angeles households to determine knowledge, attitudes, and behaviors relating to drinking and driving. Questions regarding attitudes and behaviors toward intervention into someone else's drinking and driving were included to relate to ASAP's advertising campaign, which focused on such intervention by people close to the drinker-driver. The survey included questions regarding driving and drinking behavior, attitudes regarding drinking and driving, intervention behavior and attitudes, and general demographic information. Efforts to identify risky drivers indicated that most of the heavy drinkers were risky drivers (that is, would drive after drinking five or more drinks) and that about 20% of the total sample said they would drive after consuming five or more drinks. The majority of persons surveyed were found to be well aware of the problem of drinking and driving. They consider it to be both serious and risky, a cause of traffic accidents and deaths. These people look favorably upon intervening to aid the drinker-driver, especially favoring the interventions of driving for the drinker, offering lodging, and serving food after drinking. An advertising campaign may reinforce these attitudes. However, there are small minorities of people who don't view the problem as serious, look negatively on intervention, and do not intervene in drinking-driving situations. It is suggested that this minority may constitute those who are now surrounding the drinking driver. Data on sex, ethnicity, marital status, age, occupation, and education of the 1,026 survey respondents are tabulated.

by Ruth Haugen  
County of Los Angeles Alcohol Safety Action Proj.  
Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
1975 ; 37p

Availability: Reference copy only

HS-801 879

#### **AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

The following four Alcohol Safety Action Project (ASAP) funded Alcoholism Councils located in Los Angeles County,

California, performed a total of over 8,000 post-sentence investigations and about 600 speaker's bureau events in 1974: the Alcoholism Council of San Fernando Valley; the Alcoholism Council of East San Gabriel and Pomona Valleys; the Alcoholism Council of South Central Los Angeles; and the Alcoholism Council of East Los Angeles. The Councils have the task of classifying drinking drivers with respect to the extent of their problems and recommending to them appropriate rehabilitation. They rely mainly on a volunteer counselling staff who are mostly recovered alcoholics. Examining the councils' drinker classification process as well as treatment referrals indicated a moderate discriminating ability, with alcohol-related variables appearing to be more relevant for discrimination than non-alcohol-related variables. Statistically significant differences were noted between the councils' clients with respect to alcohol-related prior referrals during the preceeding 6 years, prior crashes, and blood alcohol levels (BAC) at the arrest time. A relationship between sex, ethnicity, and BAC level at arrest time and the driving behavior prior to treatment referral was statistically proven and was supported by recidivism data. Treatment referral was shown to be a significant determinant of difference in clients' driving behavior. Persons referred to educational programs had less prior alcohol-related violations and recidivism violations than others referred to Alcoholics Anonymous (AA) or Disulfiram. Following a sample over a period of two years showed fluctuated recidivism rates during the examined intervals. Recidivism rates for AA referrals were slightly higher than driving school referral rates, tending to support the credibility of the referral process. The cost of post-sentence investigation for the councils ranged from 6.20 dollars to 19.37 dollars per client, with the cost correlating with the amount of time spent with each client. The use of volunteer counselors is estimated to have resulted in a 50% lower cost for the operation of the program.

by Nabila N. Beshai  
County of Los Angeles Alcohol Safety Action Proj.  
Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
1975 ; 101p 1ref

Availability: Reference copy only

HS-801 880

#### **AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

The Los Angeles County, California, Alcohol Safety Action Project (ASAP) has been operating two specialized driving while under the influence (DUI) enforcement patrols, Sheriff and Covina, for 2 full years. Both patrols have investigated the advantages of one versus two person units. The Sheriff's ASAP, with a large patrol area, has found two person units to be most effective because of the lengthy response time for back-up assistance to one person units. Covina has found an 83% increase in DUI arrests using one-person cars. The ratio of daytime to nighttime total crash rates was used to analyze the relationship between ASAP DUI arrests and ultimate crash reductions. The analysis indicated a significant increase in nighttime crash rates relative to daytime rates in the Sheriff's saturation patrol areas. No change in the daytime to nighttime crash ratios was observed in the Covina ASAP area. The Sheriff's patrols have increased total DUI arrest rates 194% in 1973 and 196% in 1974 as compared to pre-ASAP arrest rates. The Sheriff's ASAP arrests are up 26% over 1973, and regular patrol DUI arrests were up 115% in 1973 and 97% over

baseline in 1974. Covina has increased DUI arrests 374% in 1973 and 691% in 1974 as compared to baseline rates, with regular patrol arrest rates up 188% in 1973 and 357% in 1974 as a result of the catalytic effect from ASAP units. Covina ASAP arrests are up 80% over 1973. A portion of the fine for DUI is returned to the city in which the arrest is made. Based on the increase in DUI arrests as the result of ASAP, specialized DUI enforcement patrols can be self-sufficient. A comprehensive analysis of video tape procedure used in the field by the Sheriff's and Covina ASAP patrols suggests that video tape does not decrease court time or increase conviction rates. Such benefits as decreases in altercation rates and documentation of Miranda and Implied Consent warnings can be realized through audio recordings alone. Positive benefits include decreased officer time in court for Covina ASAP. A preliminary breath screening study indicated that such devices may aid the field officer in detecting suspects currently able to mask symptoms of intoxication as measured by the field sobriety test.

by John R. McIntire  
 County of Los Angeles Alcohol Safety Action Proj.  
 Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
 1975 ; 161p

Availability: Reference copy only

HS-801 881

#### **AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

The activities and accomplishments of the Public Information and Education (PI&E) program operated by the Los Angeles County, California, Alcohol Safety Action Project (ASAP) are described in detail. Analyses are limited to specific questions from the household and roadside surveys for 1972, 1973, and 1974 as well as the results of the pre-advertising telephone survey. The telephone survey was developed to assess the attitudes and awareness of the Los Angeles County residents regarding the problem of driving under the influence and its findings were used to develop relevant public service announcements. The announcements (three television and seven radio spots) focussed on the idea of an appeal to the "significant other" to be responsible for friends' drinking and driving. A breakdown of the costs of the announcements is appended. Comparison of the 1974 roadside and household surveys with 1973 and 1974 surveys showed an increase in awareness of the problem of driving under the influence of alcohol, of ASAP, of a campaign to reduce alcohol-related traffic deaths, and of the stepped-up police alerts. It is concluded that the Los Angeles County ASAP's public information and education efforts appear to be making gains in the area of public awareness and attitudes about the use of alcohol as it relates to driving.

by Emanda B. Miller  
 County of Los Angeles Alcohol Safety Action Proj.  
 Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
 1975 ; 94p

Availability: Reference copy only

HS-801 882

#### **AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT**

#### **(LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

A total of 1,069 Los Angeles County, California, employees were counseled and referred to treatment by the Occupational Health Services (OHS) countermeasure of the county's Alcohol Safety Action Project (ASAP). In addition, 22 training sessions were conducted in several county departments where a large number of employees are required to drive on business. The OHS client tends to be a middle-aged White married male who functions as an unskilled worker. A total of 13.4% of the OHS sample experienced alcohol-related driving violations, and 7.5% showed accident involvement during the measured recidivism period. A total of 44.7% of problem drinkers compared to 19.4% of others had two or more alcohol-related prior violations, and 7.4% of problem drinkers experienced two prior accidents, while none of the others had higher than one. Recidivism data presented converse results; 11.7% of problem drinkers experienced alcohol-related violations while 16.7% of the other group did. Comparing the OHS sample with another group of ASAP referrals indicated a differential basis with respect to alcohol-related prior violations and accidents and non-alcohol-related prior violations. The other referral sample showed more involvement in those prior violations, but OHS presented higher alcohol-related recidivism rates, 13.4% compared to 8%, as well as higher accident rates, 7.5% compared to 4.5%.

by Nabila N. Beshai  
 County of Los Angeles Alcohol Safety Proj.  
 Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
 1975 ; 29p

Availability: Reference copy only

HS-801 883

#### **AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

A study to determine the effectiveness of the major treatment programs in the Mini-Alcohol Safety Action Project area is presented. The programs include the disulfiram, the Alcoholics Anonymous (AA) and the court school programs. Regression analysis was used to determine the effectiveness of treatments with regard to the reduction of driving under the influence and crash recidivism. The effectiveness of treatment versus no treatment, the various treatment modalities, and disulfiram alone and in combination with other treatments is considered. The driving records of persons who entered treatment in 1974 after seven months of exposure to rehabilitation and persons who entered treatment in 1973 after 18 months of exposure to rehabilitation were examined. It was found that seven months after starting treatment: treatment clients had lower recidivism rates than no treatment clients for alcohol-related offenses (11.3 versus 13.2%); treatment clients had slightly higher accident recidivism rates than no treatment clients (4.6 versus 4.2%); disulfiram alone, disulfiram with AA, and AA alone all gave statistical evidence of effectiveness when compared with a no treatment group; and the most effective treatment was that which combined AA with motivational counseling. It was also found that 18 months after starting treatment: treatment clients had lower recidivism rates than no treatment clients for drunk driving offenses (17.9 versus 19.5%), almost equal rates for total alcohol-related offenses (28.4 versus 28.3%), and slightly higher rates for accident recidivisms (12.3 versus

HS-801 884

11.7%); and there is a hint that court school programs may be productive over time with regard to recidivism and the disulfiram program may be less effective over time.

Los Angeles County Alcohol Safety Action Proj.  
Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
1975? ; 77p refs

Availability: Reference copy only

HS-801 884

### **AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**

A study was conducted to assess the effectiveness of the Alcohol-Related Traffic Safety programs of the Los Angeles Unified School District. The programs were considered effective if they helped in the reduction of driving under the influence of alcohol (DUI) and crash recidivism. Effectiveness was also determined by looking to improved knowledge and attitudes with regard to alcohol and traffic safety. Regression analysis was used to determine the statistical effectiveness of the programs with regard to the reduction of DUI and crash recidivism. It was found that, for clients with seven months of program exposure: court school students had 6.8 alcohol-related offenses per 100 persons; no-treatment clients had 13.2 per 100 persons; court school students had higher rates of accident involvement (6.1 compared to 4.2 per 100); and when compared with the no-treatment group all other groups involved in the program were statistically quite improved. Among clients who had 18 months exposure it was found that: court school students had a rate of 25.4 alcohol-related offenses per 100 persons; no-treatment clients had a rate of 28.3 per 100; court school students had higher rates for accident involvement (16.1 versus 11.7 per 100 persons); and the program did not demonstrate a statistically significant effect over this longer period of time. Recidivists were shown to tend to be younger and have more prior alcohol related arrests. It was also found that those who completed the program showed a statistically significant improvement in knowledge and attitude scores on alcohol and traffic safety.

by Helen E. Burch  
County of Los Angeles Alcohol Safety Action Proj.  
Contract DOT-HS-161-2-252 Grant NIH-RR-3.  
1975? ; 61p refs

Availability: Reference copy only

HS-801 885

### **AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6**

The system of alcohol treatment services which have been used by the Hennepin County, Minnesota, Alcohol Safety Action Project (ASAP) as referral agencies for individuals identified as problem drinkers is examined. A detailed overview of the Hennepin County treatment system is provided. About 91% of the clients receiving investigation are referred to one or more treatment programs. Programs used include the project's driving while intoxicated (DWI) course and programs sponsored in the community such as the Chalk Talks, the Alcoholics Anonymous and in-patient programs. Analysis of recidivism data indicates that the entire system of diagnosis, referral, and treatment is effective. Rearrest rates for in-

dividuals without receiving an investigation are significantly higher than those rates for individuals receiving investigations and entering the ASAP system (15.8% versus 7.2%). Recidivism data for reconviction and accident involvement also support this indication. Analysis of knowledge levels of DWI course participants indicates that they generally acquire more knowledge after exposure to the class. Furthermore, despite decreases in knowledge over time, it appears that the program has a long-term effect. Cost analysis of the DWI course shows that the program can, with some modification, be self-supporting and that the cost to the project for students completing the program averages \$29 per student, in 1974. It is concluded that the short-term goal of reducing the reentry of drinking drivers into the traffic safety system is being attained.

by Stuart D. Rosen; Floyd Romslo  
Hennepin County Alcohol Safety Action Proj., Hennepin County, Minn.  
Contract DOT-HS-048-1-064  
Rept. No. HCASAP-5/30/75 ; 1975? ; 115p  
Prepared in cooperation with the University of Minnesota Program in Health Administration.  
Availability: Reference copy only

HS-801 886

### **AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1**

An evaluation of the total project impact for the 1974 operations of the City of Phoenix Alcohol Safety Action Project (ASAP) is presented. The overall objectives of the three year project, which began operations in 1972, were to achieve significant reduction in alcohol-related crashes resulting in fatalities, injuries, and property damage, and to generate public support and stimulate State and community programs to further these goals. The integrated countermeasure program directed toward the apprehension and rehabilitation of problem drinkers who drive included: increased enforcement of driving while under the influence (DWI) offenders laws through the continued use of specially-trained motorcycle police; a special judiciary process for offenders; a variety of rehabilitation options; a public information and educational effort; and an extensive project evaluation program. Analysis of motor vehicle crashes was used as the ultimate performance measure for the evaluation of the impact of the project. Accident patterns during 1974 are compared with crash trends during the project's baseline period and to prior operational years using a spectral density forecasting computer program. In addition, accident trends are compared between baseline and operational periods to assess the overall project impact during the full three year period. Statistically reliable changes in total crash frequencies were observed both between baseline and operational periods of the project and between calendar year 1974 and preceding years. In addition, a number of crash subsets were inspected and several exhibited statistically significant reductions during the operational period. Total injury crashes showed a statistically significant decrease in level during the overall operational period, with a rather abrupt shift in the trend of injury crashes beginning early in the second operational year and continuing through 1974. It is suggested that the data indicate that the Phoenix ASAP has produced a measurable reduction in injury and total crash rates, and in subsets of these crash series, during its 1972 through 1974 operational period and that the 1974 project activities produced measurable reductions in crash

trends established during previous operational and baseline years. Data on the blood alcohol concentration (BAC) distributions of fatally injured drivers indicates that the Phoenix ASAP did not have an appreciable effect in lowering the BACs of fatally injured drivers.

City of Phoenix Alcohol Safety Action Proj., ASAP  
Evaluation Unit, 251 West Washington St., Phoenix, Ariz.  
85003  
Contract DOT-HS-052-1-068  
1975 ; 234p 12refs  
Availability: Reference copy only

HS-801 887

#### **ANALYSIS OF ASAP PATROL ACTIVITY. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 3**

An evaluation of the Driving While under the Influence (DWI) enforcement countermeasures which were operational during 1974 as part of the City of Phoenix, Arizona, Alcohol Safety Action Project (ASAP) is presented. Information on DWI arrest processing was obtained from the General Traffic Procedures manual for the Phoenix Police Department and from interviews with both the ASAP and Traffic Bureau Operations officials. In addition, informal interviews and observations of officers in action on patrol were used to gain insight into ASAP enforcement strategies. A police motorcycle squad, designated as ASAP, was used to supplement normal police activities and to emphasize detection and apprehension of DWI offenders. Major steps used by both ASAP and non-ASAP officers in processing DWI arrests included detection and apprehension, field agility testing, arrest, blood alcohol concentration (BAC) testing, and booking and release procedures. Data on DWI arrests indicate that total DWI citations decreased 7% from 1973 to 1974, but that an upward trend was evident during the last months of 1974. The ASAP squad accounted for 27% of these arrests. An estimated 1.8% of the licensed drivers residing within Phoenix were cited for DWI during 1974. The average BAC was .162 for ASAP compared to .184 for non-ASAP arrests. Most citations were written between 8 p.m. and 4 a.m. and on days proximate to the weekend. One out of every five DWI arrests involved an accident. The cost incurred by the ASAP squad in making a DWI arrest was 61 dollars in 1974, compared to 85 dollars in 1973 and 63 dollars in 1972.

City of Phoenix Alcohol Safety Action Proj., ASAP  
Evaluation Unit, 251 West Washington St., Phoenix, Ariz.  
85003  
Contract DOT-HS-052-1-068  
1975 ; 99p 3refs  
Availability: Reference copy only

HS-801 888

#### **ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6**

An evaluation of drinker diagnosis and referral activity and rehabilitation countermeasures for 1974 operations of the Phoenix, Arizona, Alcohol Safety Action Project (ASAP) is presented. An overview of the Phoenix ASAP, including a description of the major countermeasure areas is provided. A detailed description of the operating characteristics of the judi-

cial/rehabilitation system is given. Three major changes are identified: a considerably shortened problem-drinker screening test was implemented in mid-1974; referral to rehabilitation was made solely contingent on the first-stage screening decision of problem or social drinker; and the primary educational/rehabilitation referral resource for ASAP clients was changed to a workshop format. Driving while intoxicated (DWI) arrest recidivism for clients entering the ASAP system during the first three years of operations is analyzed. Comparisons were made between treatment/no treatment groups, between randomly assigned DWI School and control groups, and between DWI Prevention Workshops and its closest treatment counterpart. Results for problem drinkers were in the direction of significantly lower recidivism for the group not referred to treatment, while for social drinkers those completing some form of treatment were found to have a significantly lower recidivism rate over time. Problem drinker differences favoring the Workshops were highly significant at both exposure periods (six and twelve months), while for social drinkers, significant differences in the same direction were obtained only at the longer exposure time. Results were discussed and interpreted in light of methodological constraints having to do with the way treatment groups were formed; certain analytical techniques were suggested to control between-group differences brought about when clients receive non-random treatment referrals. These recommendations are summarized and some of 1975's accomplishments are previewed.

City of Phoenix Alcohol Safety Action Proj., ASAP  
Evaluation Unit, 251 West Washington St., Phoenix, Ariz.  
85003  
Contract DOT-HS-052-1-068  
1975 ; 154p 6refs  
Availability: Reference copy only

HS-801 892

#### **THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973**

The needs of the United States in the field of traffic safety are discussed in detail. Specific highway safety problem areas were defined relating to the driver, the highway, the vehicle, and the safety management system. From these, specific countermeasures were identified which would be effective in dealing with each problem area. Based on an extensive literature search, interviews with over 1,000 State and local officials and professionals in the field, and consultation with a panel of 103 experts, 37 countermeasures of potentially high payoff were selected for analysis. Discussions of the following topics are included: federal, state, and local roles in highway safety; the magnitude and nature of the highway safety problem over the next decade; the methodology for determining countermeasures effectiveness and costs; the evaluation of countermeasures in cost effectiveness terms; systems management and support; and highway safety needs in Guam, American Samoa, and the Virgin Islands. Three countermeasures are seen to have the estimated potential to save tens of thousands of lives over the next decade: safety belt usage; nationwide 55 mph speed limit; and combined alcohol safety action countermeasures. A listing of three cost effectiveness rankings based upon three different values for loss, a discussion of counter-

measure deployment opportunity curves, and examples of countermeasure descriptions and summary data are appended.

Department of Transportation, Washington, D. C. 20590  
1976 ; 151p refs  
Availability: GPO

HS-801 893

**THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.**  
**APPENDIX A. LITERATURE SUMMARY**

As part of a study of United States highway safety needs a literature summary was conducted to: identify the major elements or target areas of the overall traffic accident problem; identify and classify actions taken to reverse current accident trends; and identify the effectiveness of these actions. The study approach and the target areas are described and the 13 selected target areas are discussed: emergency response systems; driver behavior improvement; young drivers; traffic enforcement and adjudication; bicycle and pedestrian safety; motorcycle safety; roadway safety improvements; roadside hazard elimination; traffic engineering and operations; vehicle safety operations improvements; program planning, evaluation and coordination; traffic records systems; and manpower resource development. An overview of highway safety program emphasis over the last ten years in terms of legislation, administrative policies, major research, and State and local programs is given. A bibliography is also presented including significant current documentation of the status of implementation and effectiveness of traffic accident countermeasures.

by J. E. Lema; E. W. Hauser; R. E. Darby; L. B. West; M. B. Woodside; J. C. Laughland  
Research Triangle Inst., Raleigh, N.C.  
Contract DOT-HS-5-01069  
Rept. No. 26U-1090-13 ; 1976 ; 362p refs  
Availability: GPO

HS-801 894

**THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.**  
**APPENDIX B: COUNTERMEASURES EVALUATED.**  
**APPENDIX C: ADVISORY PANEL FINDINGS.**  
**APPENDIX D: STATE SURVEYS**

Traffic accident countermeasures and support activities that were evaluated in a highway safety needs study (HSNS) conducted for the National Highway Traffic Safety Administration and the Federal Highway Administration are listed. The results of a survey to obtain a consensus of expertise on the effectiveness of traffic accident countermeasures are presented. The consensus of expertise was obtained through inputs by 103 members of an HSNS advisory panel who participated in an organized process for seeking convergence of opinion. The panel members and their employment affiliations are listed and their survey answer sheets are illustrated. Also presented are the results of interviews with state and local officials in 20 states and 593 local jurisdictions which constitute the national sample used to extrapolate national estimates and to develop projections in the HSNS. Sampling plans are ex-

plained, questionnaires are provided, and the selected respondents, data collection, and responses are described.

by J. E. Lema; E. W. Hauser; M. B. Rulison  
Research Triangle Inst., Raleigh, N.C.  
Contract DOT-HS-5-10169  
Rept. No. 26U-1090-13 ; 1976 ; 177p  
Report for December 1974-March 1976.  
Availability: GPO

## **INDEX to ABSTRACTS**



## KWOC Title Index

<b>ABRASIVE</b>		<b>ALCOHOL</b>
THE NATURE OF ABRASIVE WEAR	HS-018 530	A CRITIQUE OF THE PAPER "STATISTICAL EVALUATION OF THE EFFECTIVENESS OF ALCOHOL SAFETY ACTION"
<b>ADHESIVE</b>		HS-018 460
DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES	HS-018 492	ALCOHOL, DRUGS AND ACCIDENT RISK
<b>ADHESIVES</b>		HS-018 604
AEROSPACE STRUCTURAL ADHESIVES. FINAL REPORT	HS-018 473	AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6
<b>ADJUDICATION</b>		HS-081 885
NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU	HS-018 491	AN ANALYSIS OF LAW ENFORCEMENT COUNTER-MEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>ADMINISTRATIVE</b>		HS-081 880
NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU	HS-018 491	AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>ADMITTED</b>		HS-081 879
AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA	HS-018 629	AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>AERO</b>		HS-081 878
OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556	AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>AEROSPACE</b>		HS-081 884
AEROSPACE STRUCTURAL ADHESIVES. FINAL REPORT	HS-018 473	AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>AGE</b>		HS-081 883
AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA	HS-018 629	AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
<b>CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?</b>	HS-018 465	HS-081 882
<b>AGRICULTURAL</b>		AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)	HS-018 529	HS-081 881
<b>AIR/FUEL</b>		AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1
CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640	HS-081 886
		AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
		HS-081 877
		AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA
		HS-018 629
		ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6
		HS-081 888

BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE	HS-018 625	ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6	HS-801 888
BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADIAN DRIVERS. INTERIM REPORT	HS-018 486	ANALYSIS OF ASAP PATROL ACTIVITY. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 3	HS-801 887
BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION	HS-018 621		
EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS	HS-018 468	APPARENT THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING	HS-018 607
PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER	HS-018 635		
STATISTICAL EVALUATION OF THE EFFECTIVENESS OF "ALCOHOL SAFETY ACTION PROJECTS"	HS-018 459	ARIZONA AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1	HS-801 886
ALCOHOLISM AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 879	ANNUAL SPEED STUDY (ARIZONA)	HS-018 469
ALIGNMENT ALTERING FRONT AXLE ALIGNMENT	HS-018 571	ARMY APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS	HS-018 532
ALTERING ALTERING FRONT AXLE ALIGNMENT	HS-018 571	ARTICULATED DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES	HS-018 549
AMMONIA STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NO <sub>x</sub> (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638	PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM	HS-018 548
ANALYSES ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6	HS-801 888	ASAP AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
ANALYTIC AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6	HS-801 885	ANALYSIS OF ASAP PATROL ACTIVITY. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 3	HS-801 887
AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 880	ATMOSPHERE EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE	HS-018 624
AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1	HS-801 886	ATTEMPTING A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES	HS-018 592
		ATTITUDES A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES	HS-018 592

September 30, 1976

**AUSTRALIA**

AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA

HS-018 629

AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA

HS-018 630

**AUTO**

FAMILY DISORGANIZATION AND TEENAGE AUTO ACCIDENTS

HS-018 471

WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION

HS-018 623

**AUTOMOBILE**

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

HS-018 507

STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT

HS-018 474

**AUTOMOBILES**

ALTERNATIVE POWER SOURCES FOR LOW EMISSION AUTOMOBILES

HS-018 626

**AXLE**

ALTERING FRONT AXLE ALIGNMENT

HS-018 571

**BATTERY**

HOW TO INCREASE BATTERY LIFE

HS-018 574

**BEATING**

BEATING THE BLOWOUT WIPEOUT'

HS-018 576

**BEHAVIOR**

COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN

HS-018 611

COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.

HS-018 615

THE ROLE OF OUR LEGAL SYSTEM IN INFLUENCING DRIVER BEHAVIOR

HS-018 598

**BEHAVIOUR**

THE PREVENTION OF DANGEROUS BEHAVIOUR. 1. PREVENTION BY SELECTION: AN UNSUCCESSFUL APPROACH

HS-018 543

**BELT**

A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES

HS-018 592

ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION

HS-018 509

**BELTS**

PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

HS-018 544

**BENEFITS**

WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)

HS-018 529

**BENZ**

DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE

HS-018 581

**BICYCLING**

BICYCLING IN TENNESSEE. INVENTORY OF USERS, FACILITIES, AND PROGRAMS

HS-018 602

**BICYCLISTS**

CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?

HS-018 465

**BLACKSBURG**

INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974

HS-018 546

**BLENDED**

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

**BLOOD**

AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA

HS-018 629

BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE

HS-018 625

BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADIAN DRIVERS. INTERIM REPORT

HS-018 486

<b>BLOWOUT</b>	<b>CAPABILITY</b>
BEATING THE BLOWOUT WIPEOUT'	CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH
	HS-018 576
<b>BOLTED</b>	<b>CAR</b>
CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	HANDLING YOUR CAR ON ICE AND SNOW
	HS-018 584
<b>BORE</b>	<b>HOW SAFE AT ANY SPEED? A CRITICAL LOOK</b>
SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	TEN YEARS PROGRESS IN CAR SAFETY
	HS-018 498
<b>BRAKE</b>	<b>LOW TEMPERATURE VISCOSITY REQUIREMENT</b>
GETTING THE MOST FROM YOUR BRAKE LININGS	OF THE ITALIAN CAR POPULATION
	HS-018 572
<b>BRAKES</b>	<b>PRACTICAL AND MEDICAL ASPECTS OF THE</b>
THE CARE AND FEEDING OF COMPUTERIZED BRAKES (IF AND WHEN THEY GET HERE)	OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV
	HS-018 562
<b>BRAKING</b>	<b>CARRIER</b>
SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES	MOTOR CARRIER ACCIDENT INVESTIGATION. A JACKETON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA
	HS-018 552
<b>BREAKTHROUGH</b>	<b>CARRIERS</b>
STARTING SYSTEMS (FOR TRUCKS): THE BIG BREAKTHROUGH	SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE, 1971
	HS-018 563
<b>BREATH</b>	SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JULY THROUGH DECEMBER 1972
BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION	HS-018 621
	SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE 1973
<b>BREATHERS</b>	SELECTED SAFETY ROAD CHECKS. MOTOR CARRIERS OF PROPERTY. 1970
HYDRAULIC RESERVOIR BREATHERS. HOW GOOD	HS-018 540
	HS-018 618
<b>BRIDGES</b>	<b>CASE</b>
REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES	OSCILLATORY INSTABILITY OF A SEMITRAILER VEHICLE--A CASE STUDY
	HS-018 565
<b>CALCULATION</b>	<b>CASUALTIES</b>
CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA
	HS-018 584
<b>CALSPAN</b>	<b>CATALYST</b>
EXPERIMENTAL VALIDATION OF THE CALSPAN TIRE RESEARCH FACILITY. VOL. 1. FINAL REPORT	STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND CONTROL IN THE NO <sub>x</sub> (OXIDES OF NITROGEN) CATALYST SYSTEM
	HS-018 481
<b>CAMS</b>	<b>CATALYSTS</b>
EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS	LABORATORY EVALUATION OF THREE-V
	HS-018 578
<b>CANADIAN</b>	
BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADIAN DRIVERS. INTERIM REPORT	HS-018 486

September 30, 1976

#### CATALYTIC

COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS

HS-018 582

NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT

HS-018 637

SAFETY OF CATALYTIC CONVERTER QUESTIONED

HS-018 542

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

STRATIFIED CHARGE ENGINES. FINAL REPORT

HS-018 613

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

#### CENTRAL

EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE

HS-018 624

#### CHAMBER

A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER

HS-018 589

COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

HS-018 590

#### CHAMBERS

TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS

HS-018 587

#### CHARACTERISTICS

LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES

HS-018 560

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER

HS-018 588

#### CHARACTERIZATION

CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR

HS-018 514

CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

HS-018 640

#### CHILDREN

CHILDREN AND ROAD SAFETY: A SURVEY AMONGST MOTHERS

HS-018 597

CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?

HS-018 465

#### CLEAN

EFFICIENT AND CLEAN DIESEL COMBUSTION

HS-018 519

#### COLLISION

COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN

HS-018 611

COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.

HS-018 615

#### COMBUSTION

A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER

HS-018 589

COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

HS-018 590

EFFICIENT AND CLEAN DIESEL COMBUSTION

HS-018 519

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS-018 585

THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER

HS-018 588

#### CHARGE

COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

HS-018 590

THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL	HS-018 622	THE PRO AND CON OF MOTORCYCLE LAWS. IF YOU RIDE, YOU DECIDE
TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS	HS-018 587	CONCENTRATIONS
COMMENT		BLOOD ALCOHOL CONCENTRATION SCANDINAVIAN DRIVERS: DATA NORTHERN COUNTRIES IN INTERNA SPECTIVE
COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.	HS-018 615	EFFECTS OF THE MOTOR VEHICLE C GRAM ON HYDROCARBON CONCEN THE CENTRAL LOS ANGELES ATMOSI
COMPARATIVE		CONCRETE
TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES	HS-018 513	DETERMINATION OF ADHESIVE CHARACTERIZING THE INTERACTIO MATIC TIRES AND CONCRETE PAVI PULL-SLIP CURVES
COMPARISON		CONFERENCE
A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING	HS-018 553	INTERNATIONAL CONFERENCE O SYSTEM DYNAMICS (3RD) P BLACKSBURG, VIRGINIA, AUG. 12-15, 1
COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS	HS-018 582	CONFIGURATIONS
COMPILATION		RESPONSE OF NAIVE DRIVERS TO PR STOP SIGNALS OF EXPERIMENTAL RE CONFIGURATIONS
ACCIDENT SOURCE COMPILATION. FINAL REPORT	HS-018 467	CONGRESS
COMPONENT		THE NATIONAL HIGHWAY SAFETY NE REPORT OF THE SECRETARY OF TRAN TO THE UNITED STATES CONGRESS P SECTION 225 OF THE HIGHWAY SAF 1973
APPLIED PHOTOLELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS	HS-018 583	CONNECTION
FILTER SELECTION BASED ON COMPONENT SENSITIVITY ANALYSIS	HS-018 535	CALCULATION OF A DYNAMICALLY TRICALLY LOADED BOLTED CONN TION ACCORDING TO VDI 2230
COMPOUND		CONROD
THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL	HS-018 622	CALCULATION OF A DYNAMICALLY TRICALLY LOADED BOLTED CONN TION ACCORDING TO VDI 2230
COMPULSORY		CONSERVATION
AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA	HS-018 629	CONTROLLING VARIABLE DI HYDRAULIC PUMPS FOR ENERGY CON
AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA	HS-018 630	CONSTRUCTION
COMPUTERIZED		EXHAUST EMISSIONS FROM FARM TION, AND INDUSTRIAL ENGINES AF PACT
THE CARE AND FEEDING OF COMPUTERIZED BRAKES (IF AND WHEN THEY GET HERE)	HS-018 562	CONTROL
CON		CHARACTERIZATION OF ZIRCONIA / ENGINE EXHAUST GAS SENSORS / FEEDBACK CONTROL SYSTEMS
THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES	HS-018 616	

September 30, 1976

EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE	HS-018 624	AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 884
HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT	HS-018 487	AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 882
INTER-INDUSTRY EMISSION CONTROL PROGRAM 2 (IIEC-2) PROGRAM REPORT NO. 2	HS-018 632	AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 881
SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	HS-018 498	AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 880
STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638	AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
WHY TRAFFIC CONTROL IS A MUST <sup>X</sup>	HS-018 627	THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894
<b>CONTROLS</b>		<b>COUNTERMEASURES</b>	
DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS	HS-018 596	AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 880
<b>CONVERTER</b>		AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT	HS-018 637	THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894
SAFETY OF CATALYTIC CONVERTER QUESTIONED	HS-018 542	<b>COUNTRIES</b>	
THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE	HS-018 580	BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE	HS-018 625
<b>COOLED</b>		<b>COUNTRY</b>	
CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586	TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)	HS-018 461
<b>CORE</b>		<b>COUNTY</b>	
CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586	AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 880
<b>CORRECTION</b>		AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 879
CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586	AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 878
<b>CORRELATION</b>		AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 884
PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT	HS-018 541	AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
<b>COUNCILS</b>		AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 879	AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 884
<b>COUNTERMEASURE</b>		AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883
AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 879	AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 884

ANALYSIS OF THE OCCUPATIONAL HEALTH AND SAFETY COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-018 882	THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER	HS-018 588
ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-018 881	DAMPER	THE APPLICATION OF AN ELECTROVISCOUS DAMPER TO A VEHICLE SUSPENSION SYSTEM
ANALYSIS OF ULTIMATE PERFORMANCE MEASUREMENTS: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-018 877	DANGEROUS	HS-018 551
ATES OF MOTOR VEHICLE SEAT BELT EFFICACY AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION	HS-018 509	THE PREVENTION OF DANGEROUS BEHAVIOUR. 1. PREVENTION BY SELECTION: AN UNSUCCESSFUL APPROACH	HS-018 543
U (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR HELMETS	HS-018 508	DAYS	TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)
ES			HS-018 461
ITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT THES	HS-018 603	DAYTIME	AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA
AL			HS-018 630
U (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR HELMETS	HS-018 508	DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION	HS-018 593
UE			
CRITIQUE OF THE PAPER "STATISTICAL EVALUATION OF THE EFFECTIVENESS OF ALCOHOL SAFETY ACTION"	HS-018 460	DECIDE	THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE
NG			HS-018 617
ITY OF PEDESTRIAN CROSSING FACILITIES	HS-018 594	DECISION	RISK TAKING AS A DECISION PROCESS IN DRIVING
D			HS-018 512
ATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS	HS-018 472	DEFECT	MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS
6			HS-018 848
TERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM SLIP CURVES	HS-018 492	DEGREES	PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM
HUNDRED YEARS OF THE OTTO-CYCLE EN-	HS-018 601		HS-018 548
ER		DELAYS	SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS
N AND RESULTS OF THE FIVE-CYLINDER EDES-BENZ DIESEL ENGINE	HS-018 581		HS-018 550
60		DEMONSTRATION	SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT
			HS-018 484
		DESIGNS	TIRE DESIGNS FOR MOBILITY--USSR
			HS-018 493

September

DETECTION  
DAYTIME  
DETECTION  
AND ALCOHOLDIAGNOSTIC  
ANALYSIS  
RAL ANALYSIS  
EFFORTS  
ANALYSISDIAGNOSTIC  
AUTOMATIONDIESEL  
A FULL  
PROBLEMS  
DIESELA NEW  
JECTIVE  
EMISSIONSDESIGN  
MERCER

EFFICIENCY

EXPERIMENTAL  
ENGINE  
ENGINENEW  
SOLUTIONSPREDICTION  
DIESELSMALL  
FRACTION  
ATE OFDIRECT  
DIRECT  
STUDIESDISEASE  
NEW MODELSDISORGANIZATION  
FAMILIES  
ACCIDENTSDISPLACEMENT  
CONTROLS  
HYDRAULICS

ber 30, 1976

## TION

IME RUNNING LIGHTS PROJECT. 2. VEHICLE  
CTION AS A FUNCTION OF HEADLIGHT USE  
MBIENT ILLUMINATION

HS-018 593

## OSIS

YSES OF DRINKER DIAGNOSIS AND REFER-  
ACTIVITY AND ALCOHOL REHABILITATION  
RTS. ANNUAL REPORT 1974. SECTION 2.  
YTIC STUDIES 5 AND 6

HS-801 888

## STIC

MOTIVE DIAGNOSTIC AND REPAIR EQUIP-

HS-018 631

JNDAMENTAL INVESTIGATION INTO THE  
LEM OF NO (NITRIC OXIDE) FORMATION IN  
L ENGINES

HS-018 536

W DIESEL INJECTION PUMP WITH HIGH IN-  
ON RATE, ITS INFLUENCE ON SMOKE AND  
IONS

HS-018 515

N AND RESULTS OF THE FIVE-CYLINDER  
EDES-BENZ DIESEL ENGINE

HS-018 581

IENT AND CLEAN DIESEL COMBUSTION  
HS-018 519

RIENCES WITH MULTIGRADE HEAVY DUTY  
E OILS IN MILITARY GASOLINE AND DIESEL  
ES

HS-018 523

METHODS FOR REDUCING VISIBLE EMIS-  
OF DIESEL ENGINES

HS-018 503

CTION OF RADIATIVE HEAT FLUX IN A  
L ENGINE

HS-018 518

L BORE DIESEL ENGINE TESTING USING THE  
TIONAL FACTORIAL TECHNIQUE TO EVALU-  
IL CONTROL

HS-018 498

CT AND INDIRECT METHODS FOR STABILITY  
ES OF ARTICULATED VEHICLES

HS-018 549

E  
DEVELOPMENTS IN PISTON RINGS FOR THE  
RN DISEASE ENGINE

HS-018 494

ANIZATION  
Y DISORGANIZATION AND TEENAGE AUTO  
ENTS

HS-018 471

CEMENT  
ROLLING VARIABLE DISPLACEMENT  
AULIC PUMPS FOR ENERGY CONSERVATION

HS-018 526

## DIVERSION

HUMAN FACTOR REVIEW OF TRAFFIC CONTROL  
AND DIVERSION PROJECTS. FINAL REPORT

HS-018 487

## DOSES

EFFECTS OF SMALL DOSES OF ALCOHOL ON  
DRIVER PERFORMANCE IN EMERGENCY TRAFFIC  
SITUATIONS

HS-018 468

## DRINKER

ANALYSES OF DRINKER DIAGNOSIS AND REFER-  
ACTIVITY AND ALCOHOL REHABILITATION  
EFFORTS. ANNUAL REPORT 1974. SECTION 2.  
ANALYTIC STUDIES 5 AND 6

HS-801 888

## DRINKING

DRINKING AND DRIVING IN OTHER LANDS  
HS-018 618

## DRIVE

V DRIVE (NEW FOUR WHEEL DRIVE SYSTEM)  
HS-018 568

## DRIVER

DRIVER ERROR  
HS-018 511

DRIVER EXPECTANCY AND PERFORMANCE IN  
LOCATING AUTOMOTIVE CONTROLS  
HS-018 596

DRIVER RESPONSE TO VOLUNTARY AND MANDA-  
TORY SPEED LIMITS  
HS-018 567

DRIVER SAFETY IN MODIFIED VANS  
HS-018 591

EFFECTS OF SMALL DOSES OF ALCOHOL ON  
DRIVER PERFORMANCE IN EMERGENCY TRAFFIC  
SITUATIONS  
HS-018 468

OPTIMAL AERO-MECHANICAL DESIGN FOR SPE-  
CIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE  
SYSTEMS  
HS-018 556

REEDUCATION AND REHABILITATION OF THE  
DRUNKEN DRIVER  
HS-018 620

THE ROLE OF OUR LEGAL SYSTEM IN INFLUENC-  
ING DRIVER BEHAVIOR  
HS-018 598

1976 DRIVER LICENSE ADMINISTRATION REQUIRE-  
MENTS AND FEES  
HS-018 561

## DRIVERS

BLOOD ALCOHOL CONCENTRATIONS AMONG  
SCANDINAVIAN DRIVERS: DATA FROM THE  
NORTHERN COUNTRIES IN INTERNATIONAL PER-  
SPECTIVE  
HS-018 625

BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADI-  
AN DRIVERS. INTERIM REPORT  
HS-018 486

COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN	HS-018 611	ECONOMY	STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT
COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.	HS-018 615		HS-018 464
RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477	THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2	HS-018 636
<b>DRIVING</b>		THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL	HS-018 622
DRINKING AND DRIVING IN OTHER LANDS	HS-018 618		
DRIVING SIMULATOR DESIGN FOR REALISTIC HANDLING	HS-018 554		
MARIHUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE	HS-018 458	<b>EDUCATION</b>	AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
RISK TAKING AS A DECISION PROCESS IN DRIVING	HS-018 512		HS-801 881
<b>DRUGS</b>		<b>EFFICIENCY</b>	INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS
ALCOHOL, DRUGS AND ACCIDENT RISK	HS-018 604		HS-018 507
<b>DRUNKEN</b>		<b>EFFICIENT</b>	EFFICIENT AND CLEAN DIESEL COMBUSTION
REEDUCATION AND REHABILITATION OF THE DRUNKEN DRIVER	HS-018 620		HS-018 519
<b>DUTY</b>		<b>ELASTOMERIC</b>	THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES
EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	HS-018 523		HS-018 528
HEAVY-DUTY TRUCK SUSPENSIONS	HS-018 600	<b>ELECTRIC</b>	PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE
<b>DYNAMICALLY</b>			HS-018 559
CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	HS-018 584	<b>ELECTRONIC</b>	FIELD TEST EXPERIENCE WITH NEW ELECTRONIC GOVERNOR
<b>DYNAMICS</b>			HS-018 499
INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974	HS-018 546	WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)	HS-018 529
<b>ECCENTRICALLY</b>		<b>ELECTROVISCOSUS</b>	THE APPLICATION OF AN ELECTROVISCOSUS DAMPER TO A VEHICLE SUSPENSION SYSTEM
CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	HS-018 584		HS-018 551
<b>ECONOMIC</b>		<b>EMERGENCY</b>	EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS
INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS	HS-018 507		HS-018 468
		<b>EMISSION</b>	ALTERNATIVE POWER SOURCES FOR LOW EMISSION AUTOMOBILES
			HS-018 626
		COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM	HS-018 590

September 30, 1976

INTER-INDUSTRY EMISSION CONTROL PROGRAM 2  
(IIEC-2) PROGRAM REPORT NO. 2

HS-018 632

EMISSIONS

A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS

HS-018 515

AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT

HS-018 564

EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT

HS-018 520

NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES

HS-018 503

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL

HS-018 622

ENERGY

CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION

HS-018 526

ENERGY AND TRANSPORTATION

HS-018 595

ENFORCEMENT

AN ANALYSIS OF LAW ENFORCEMENT COUNTER-MEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-018 880

NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

HS-018 508

ENGINE

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

HS-018 532

APPLIED PHOTOELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS

HS-018 583

CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

HS-018 640

COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

HS-018 590

DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE

HS-018 581

EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES

HS-018 523

MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION

HS-018 522

NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DIESEL ENGINE

HS-018 494

ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE

HS-018 601

PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE

HS-018 518

SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL

HS-018 498

TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES

HS-018 545

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER

HS-018 588

THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL

HS-018 622

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS

HS-018 587

VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS

HS-018 531

ENGINES

A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES

HS-018 536

EUROPEAN OILS FOR SPARK IGNITION ENGINES

HS-018 566

EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT

HS-018 520

EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES

HS-018 523

FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS

HS-018 521

NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES	HS-018 503
STRATIFIED CHARGE ENGINES. FINAL REPORT	HS-018 613
<b>EPIDEMIOLOGIC</b>	
AN EVALUATION OF EPIDEMIOLOGIC STUDIES RELATED TO ACCIDENT PREVENTION	HS-018 470
<b>EQUIPMENT</b>	
AUTOMOTIVE DIAGNOSTIC AND REPAIR EQUIPMENT	HS-018 631
WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)	HS-018 529
<b>ERROR</b>	
DRIVER ERROR	HS-018 511
<b>ESTIMATES</b>	
ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION	HS-018 509
<b>EUROPEAN</b>	
EUROPEAN OILS FOR SPARK IGNITION ENGINES	HS-018 566
EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS	HS-018 578
EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST	HS-018 579
<b>EVALUATE</b>	
SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	HS-018 498
<b>EVALUATED</b>	
THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894
<b>EXCHANGER</b>	
CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586
<b>EXHAUST</b>	
CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640
COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM	HS-018 590
EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT	HS-018 520
THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2	HS-018 636
THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL	HS-018 622
<b>EXPECTANCY</b>	
DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS	HS-018 596
<b>EXPERIENCES</b>	
EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	HS-018 523
<b>EXPLOITING</b>	
EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP	HS-018 524
<b>FACTORIAL</b>	
SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	HS-018 498
<b>FAILURES</b>	
FIGHTING FRONT TIRE FAILURES	HS-018 573
<b>FAMILY</b>	
FAMILY DISORGANIZATION AND TEENAGE AUTO ACCIDENTS	HS-018 471
<b>FARM</b>	
EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT	HS-018 520
<b>FATAL</b>	
FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974	HS-018 570
PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES	HS-018 603
<b>FEDERAL</b>	
FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974	HS-018 570
<b>FEEDBACK</b>	
CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640

September 30, 1976

**FEEDING**

THE CARE AND FEEDING OF COMPUTERIZED BRAKES (IF AND WHEN THEY GET HERE)

HS-018 562

**FEES**

1976 DRIVER LICENSE ADMINISTRATION REQUIREMENTS AND FEES

HS-018 561

**FERROFLUIDIC**

NON-WEARING FERROFLUIDIC SEALS

HS-018 537

**FIGHTING**

FIGHTING FRONT TIRE FAILURES

HS-018 573

**FILTER**

FILTER SELECTION BASED ON COMPONENT SENSITIVITY ANALYSIS

HS-018 535

LUBE OIL FILTER EVALUATION

HS-018 533

THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE

HS-018 534

**FINITE**

FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING

HS-018 558

**FINNISH**

TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS

HS-018 457

**FITS**

IF THE TIRE FITS, BUY IT

HS-018 569

**FLEET**

MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION

HS-018 522

SMALL FLEET SAFETY PROGRAM

HS-018 575

**FLOW**

TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS

HS-018 587

**FLUID**

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

HS-018 532

EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL

HS-018 527

**FLUX**

PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE

HS-018 518

**FOLLOWERS**

EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS

HS-018 578

**FORENSIC**

BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION

HS-018 621

**FORMATION**

A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES

HS-018 536

STUDY OF NH<sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM

HS-018 638

**FORWARD**

THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING

HS-018 607

**FRACTIONAL**

SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL

HS-018 498

**FREEDOM**

PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM

HS-018 548

**FRICITION**

EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL

HS-018 527

PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT

HS-018 541

**FRONT**

ALTERING FRONT AXLE ALIGNMENT

HS-018 571

FIGHTING FRONT TIRE FAILURES

HS-018 573

**FUEL**

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

HS-018 507

STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT

HS-018 464

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL

HS-018 622

**FUELS**

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

**FUNCTION**

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION

HS-018 593

**FUNDAMENTAL**

A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES

HS-018 536

**GAS**

CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

HS-018 640

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

**GASOLINE**

EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES

HS-018 523

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

**GOVERNOR**

FIELD TEST EXPERIENCE WITH NEW ELECTRONIC GOVERNOR

HS-018 499

**HANDBOOK**

SNOWMOBILE HANDBOOK. LAWS AND REGULATIONS

HS-018 506

**HANDLING**

A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING

HS-018 553

DRIVING SIMULATOR DESIGN FOR REALISTIC HANDLING

HS-018 554

HANDLING TRAFFIC CASES: A BETTER WAY

HS-018 490

HANDLING YOUR CAR ON ICE AND SNOW

HS-018 628

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 557

**HAZARD**

IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT

HS-018 462

PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES

HS-018 603

**HEADLIGHT**

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION

HS-018 593

**HEADLIGHTS**

AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA

HS-018 630

**HEALTH**

AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-801 882

**HEAT**

CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE

HS-018 518

**HELMET**

THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES

HS-018 616

THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE

HS-018 617

**HELMETS**

NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

HS-018 508

**HIGH**

A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS

HS-018 515

TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES

HS-018 545

THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES

HS-018 528

September 30, 1976

## HIGHWAY

FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974  
HS-018 570

## THE HIGHWAY KILLER-COMBINATION

HS-018 482

THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973

HS-018 892

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A. LITERATURE SUMMARY

HS-018 893

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS

HS-018 894

## HONEYCOMB

COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS  
HS-018 582

## HOSPITAL

AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA  
HS-018 629

## HOUSEHOLD

AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-018 878

## HUMAN

HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT  
HS-018 487

## HUNDRED

ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE  
HS-018 601

## HYDRAULIC

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS  
HS-018 532

CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION  
HS-018 526

HYDRAULIC RESERVOIR BREATHERS. HOW GOOD  
HS-018 540

## HYDROCARBON

EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE  
HS-018 624

## HYDROSTATIC

LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW APPROACH  
HS-018 525

## ICE

HANDLING YOUR CAR ON ICE AND SNOW  
HS-018 628

## IDENTIFICATION

IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT  
HS-018 462

## IF

IF THE TIRE FITS, BUY IT  
HS-018 569

THE CARE AND FEEDING OF COMPUTERIZED BRAKES (IF AND WHEN THEY GET HERE)  
HS-018 562

THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE  
HS-018 617

## IGNITION

A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER  
HS-018 589

EUROPEAN OILS FOR SPARK IGNITION ENGINES  
HS-018 566

TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS  
HS-018 587

## IIEC

INTER-INDUSTRY EMISSION CONTROL PROGRAM 2 (IIEC-2) PROGRAM REPORT NO. 2  
HS-018 632

## ILLUMINATION

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION  
HS-018 593

## IMPACT

AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY I  
HS-018 886

EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT  
HS-018 520

FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING  
HS-018 558

LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES  
HS-018 560

## IMPACTS

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS  
HS-018 507

**IMPLICATIONS**

ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION

HS-018 509

**IMPROVEMENTS**

IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT

HS-018 462

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 557

**INCREASE**

HOW TO INCREASE BATTERY LIFE

HS-018 574

MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES

HS-018 634

ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES

HS-018 633

**INDIANA**

MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA

HS-018 612

**INDIANAPOLIS**

MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA

HS-018 612

**INDICATOR**

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS-018 585

**INDIRECT**

DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES

HS-018 549

**INDISCOPE**

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS-018 585

**INDUSTRIAL**

EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT

HS-018 520

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

HS-018 507

WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION

HS-018 623

**INDUSTRY**

INTER-INDUSTRY EMISSION CONTROL PROGRAM 2 (IIEC-2) PROGRAM REPORT NO. 2

HS-018 632

**INFLUENCES**

A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING

HS-018 553

**INJECTION**

A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS

HS-018 515

**INJECTOR**

CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR

HS-018 514

**INJURY**

FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974

HS-018 570

**INNOVATIVE**

INNOVATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS

HS-018 472

**INPUT**

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

HS-018 507

**INSTABILITY**

OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY

HS-018 547

**INSTITUTE**

NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

HS-018 508

PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

HS-018 544

**INTER**

INTER-INDUSTRY EMISSION CONTROL PROGRAM 2 (IIEC-2) PROGRAM REPORT NO. 2

HS-018 632

THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING

HS-018 607

**INTERACTION**

DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES

HS-018 492

September 30, 1976

**INTERFEROMETER**

A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER

HS-018 589

**INTERNAL**

THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER

HS-018 588

**INTERPRETATION**

INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)

HS-018 476

**INVENTORY**

BICYCLING IN TENNESSEE. INVENTORY OF USERS, FACILITIES, AND PROGRAMS

HS-018 602

**INVESTIGATIONS**

INVESTIGATIONS INTO LIGHT TRAFFIC 2

HS-018 495

**ITALIAN**

LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION

HS-018 577

**JACKSON**

MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA

HS-018 612

**JUSTICE**

NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

HS-018 508

**KILLER**

THE HIGHWAY KILLER-COMBINATION

HS-018 482

**KNOCK**

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

**LANDS**

DRINKING AND DRIVING IN OTHER LANDS

HS-018 618

**LASER**

A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER

HS-018 589

**LAW**

AN ANALYSIS OF LAW ENFORCEMENT COUNTER-MEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-801 880

NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS

HS-018 508

**LAWS**

SNOWMOBILE HANDBOOK. LAWS AND REGULATIONS

HS-018 506

THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES

HS-018 616

THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE

HS-018 617

**LEAKAGE**

THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE

HS-018 534

**LEGAL**

THE ROLE OF OUR LEGAL SYSTEM IN INFLUENCING DRIVER BEHAVIOR

HS-018 598

**LENGTH**

CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

**LICENSE**

1976 DRIVER LICENSE ADMINISTRATION REQUIREMENTS AND FEES

HS-018 561

**LIFE**

HOW TO INCREASE BATTERY LIFE

HS-018 574

**LIGHTING**

INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)

HS-018 476

RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS

HS-018 477

STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT

HS-018 474

**LIGHTS**

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION

HS-018 593

**LIMITING**

LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES

HS-018 560

**LININGS**

GETTING THE MOST FROM YOUR BRAKE LININGS

HS-018 572

<b>LIP</b>	THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES	HS-018 528	<b>MARIHUANA</b>	MARIHUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE	HS-018 458
<b>LIVES</b>	THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES	HS-018 616	<b>MARKERS</b>	INNOVATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS	HS-018 472
<b>LOAD</b>	LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW APPROACH	HS-018 525	<b>MATERIAL</b>	EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL	HS-018 527
	TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES	HS-018 513	<b>MEASUREMENT</b>	THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER	HS-018 588
<b>LOADED</b>	CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	HS-018 584	<b>MEASURES</b>	AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-018 877
<b>LOADING</b>	FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING	HS-018 558	<b>MECHANICAL</b>	OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556
<b>LOCATING</b>	DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS	HS-018 596	<b>MEDICAL</b>	PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV	HS-018 544
<b>LOCK</b>	SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES	HS-018 552	<b>MERCEDES</b>	DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE	HS-018 581
<b>LOOP</b>	OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556	<b>METAL</b>	FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING	HS-018 558
<b>LUBE</b>	LUBE OIL FILTER EVALUATION	HS-018 533	<b>MILITARY</b>	EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	HS-018 523
<b>LUBRICANT</b>	MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION	HS-018 522	<b>MINI</b>	AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-018 883
<b>LUBRICATING</b>	FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS	HS-018 521	<b>MINIMUM</b>	CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?	HS-018 465
<b>MAN</b>	OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556	<b>MIXED</b>	MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION	HS-018 522
<b>MANDATORY</b>	DRIVER RESPONSE TO VOLUNTARY AND MANDATORY SPEED LIMITS	HS-018 567			

September 30, 1976

<b>MOBILITY</b> TIRE DESIGNS FOR MOBILITY--USSR	HS-018 493	<b>MOTORCYCLE</b> AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA	HS-018 630
<b>MODIFICATION</b> PRIORITY FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES	HS-018 603	FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS	HS-018 521
<b>MODIFIED</b> DRIVER SAFETY IN MODIFIED VANS	HS-018 591	THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES	HS-018 616
<b>MONITORING</b> WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)	HS-018 529	THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE	HS-018 617
<b>MOTHERS</b> CHILDREN AND ROAD SAFETY: A SURVEY AMONGST MOTHERS	HS-018 597	<b>MULTIGRADE</b> EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	HS-018 523
<b>MOTOR</b> EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE	HS-018 624	<b>NAIVE</b> RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477
ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION	HS-018 509	<b>NARROW</b> REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES	HS-018 565
MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA	HS-018 612	<b>NATIONAL</b> NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS	HS-018 508
MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS	HS-801 848	THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973	HS-801 892
NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU	HS-018 491	THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A. LITERATURE SUMMARY	HS-801 893
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE, 1971	HS-018 605	THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE 1973	HS-018 609	<b>NATURE</b> THE NATURE OF ABRASIVE WEAR	HS-018 530
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JULY THROUGH DECEMBER 1972	HS-018 608	<b>NEAR</b> A LASER INTERFEROMETER STUDY OF COMBUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER	HS-018 589
SELECTED SAFETY ROAD CHECKS. MOTOR CARRIERS OF PROPERTY. 1970	HS-018 606	<b>NEEDS</b> THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO	
STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT	HS-018 464		
TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES	HS-018 513		

SECTION 225 OF THE HIGHWAY SAFETY ACT OF  
1973 HS-801 892

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.  
APPENDIX A: LITERATURE SUMMARY HS-801 893

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.  
APPENDIX B: COUNTERMEASURES EVALUATED.  
APPENDIX C: ADVISORY PANEL FINDINGS. APPEN-  
DIX D: STATE SURVEYS HS-801 894

**NETWORKS**  
SCHEDULING DELAYS IN SYNCHRONOUS TRANS-  
PORTATION NETWORKS HS-018 550

**NH**  
STUDY OF NH<sub>3</sub> (AMMONIA) FORMATION AND ITS  
CONTROL IN THE NOX (OXIDES OF NITROGEN)  
CATALYST SYSTEM HS-018 638

**NIGHTTIME**  
BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADI-  
AN DRIVERS. INTERIM REPORT HS-018 486

**NILECJ**  
NILECJ (NATIONAL INSTITUTE OF LAW ENFORCE-  
MENT AND CRIMINAL JUSTICE) STANDARD FOR  
CRASH HELMETS HS-018 508

**NITRIC**  
A FUNDAMENTAL INVESTIGATION INTO THE  
PROBLEM OF NO (NITRIC OXIDE) FORMATION IN  
DIESEL ENGINES HS-018 536

**NITROGEN**  
NOX (OXIDES OF NITROGEN) CATALYTIC CON-  
VERTER DEVELOPMENT HS-018 637

STUDY OF NH<sub>3</sub> (AMMONIA) FORMATION AND ITS  
CONTROL IN THE NOX (OXIDES OF NITROGEN)  
CATALYST SYSTEM HS-018 638

**NORTHERN**  
BLOOD ALCOHOL CONCENTRATIONS AMONG  
SCANDINAVIAN DRIVERS: DATA FROM THE  
NORTHERN COUNTRIES IN INTERNATIONAL PER-  
SPECTIVE HS-018 625

**NOX**  
NOX (OXIDES OF NITROGEN) CATALYTIC CON-  
VERTER DEVELOPMENT HS-018 637

STUDY OF NH<sub>3</sub> (AMMONIA) FORMATION AND ITS  
CONTROL IN THE NOX (OXIDES OF NITROGEN)  
CATALYST SYSTEM HS-018 638

**OBJECT**

PRIORITIES FOR ROADSIDE HAZARD MODIFICA-  
TION: A STUDY OF 300 FATAL ROADSIDE OBJECT  
CRASHES HS-018 603

**OBTAINING**

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN  
THE HANDLING QUALITIES AND PERFORMANCE  
OF A SUBMERGED VEHICLE HS-018 557

**OCCUPANT**

ESTIMATES OF MOTOR VEHICLE SEAT BELT EF-  
FECTIVENESS AND USE: IMPLICATIONS FOR OCCU-  
PANT CRASH PROTECTION HS-018 509

OCCUPANT PROTECTION IN VEHICLE ROLLOVER  
HS-018 483

**OCCUPATIONAL**

AN ANALYSIS OF THE OCCUPATIONAL HEALTH  
SERVICE COUNTERMEASURE: FINAL REPORT (LOS  
ANGELES COUNTY ALCOHOL SAFETY ACTION  
PROJECT) HS-018 882

**OCTANE**

MORE DATA ON ORI (OCTANE REQUIREMENT IN-  
CREASE) VARIABLES HS-018 634

ORI (OCTANE REQUIREMENT INCREASE) OF  
TODAY'S VEHICLES HS-018 633

**OIL**

FOUR STROKE MOTORCYCLE ENGINES A STUDY  
OF THEIR LUBRICATING OIL REQUIREMENTS  
HS-018 521

LUBE OIL FILTER EVALUATION HS-018 533

SMALL BORE DIESEL ENGINE TESTING USING THE  
FRACTIONAL FACTORIAL TECHNIQUE TO EVALU-  
ATE OIL CONTROL HS-018 498

TEMPORARY ENGINE OIL VISCOSITY CHANGES AT  
HIGH TEMPERATURES HS-018 545

**OILS**

APPLICATION OF SYNTHETIC ENGINE OILS IN  
ARMY HYDRAULIC AND POWER TRANSMISSION  
FLUID SYSTEMS HS-018 532

EUROPEAN OILS FOR SPARK IGNITION ENGINES  
HS-018 566

EXPERIENCES WITH MULTIGRADE HEAVY DUTY  
ENGINE OILS IN MILITARY GASOLINE AND DIESEL  
ENGINES HS-018 523

VEHICLE EVALUATION OF SYNTHETIC AND CON-  
VENTIONAL ENGINE OILS HS-018 531

September 30, 1976

**OPERATION**

MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION

HS-018 522

PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE

HS-018 559

THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES

HS-018 528

**OPERATOR**

TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES

HS-018 513

**OPINION**

BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION

HS-018 621

**OPPOSITION**

WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION

HS-018 623

**OPTIMAL**

OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS

HS-018 556

**ORI**

MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES

HS-018 634

ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES

HS-018 633

**OSCILLATORY**

OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY

HS-018 547

**OTTO**

ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE

HS-018 601

**OUT**

TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS

HS-018 457

**OUTPUT**

INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS

HS-018 507

**OXIDE**

A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES

HS-018 536

**OXIDES**

NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT

HS-018 637

STUDY OF NH<sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM

HS-018 638

**PANEL**

STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT

HS-018 464

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS

HS-801 894

**PARAMETER**

PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM

HS-018 548

**PART**

THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2

HS-018 636

**PASS**

THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE

HS-018 534

**PATIENTS**

TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS

HS-018 457

**PATROL**

ANALYSIS OF ASAP PATROL ACTIVITY. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 3

HS-801 887

**PAVEMENT**

DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES

HS-018 492

PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT

HS-018 541

**PCI**

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

**PEDESTRIAN**

SAFETY OF PEDESTRIAN CROSSING FACILITIES

HS-018 594

**PERCEPTION**

PERCEPTION OF RELATIVE VELOCITY

HS-018 478

**PERFORMANCE**

AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-018 877

DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS

HS-018 596

EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL

HS-018 527

EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS

HS-018 468

LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES

HS-018 560

MARIHUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE

HS-018 458

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 557

THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE

HS-018 534

**PERSPECTIVE**

BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE

HS-018 625

**PHOENIX**

AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1

HS-018 886

**PHOTOELASTICITY**

APPLIED PHOTOELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS

HS-018 583

**PISTON**

AN INVESTIGATION INTO PISTON RING SCUFFING DURING RUNNING-IN

HS-018 539

EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP

HS-018 524

NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE

HS-018 494

**PNEUMATIC**

DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF AUTOMATIC TIRES AND CONCRETE PAVEMENT PULL-SLIP CURVES

HS

**POPULATION**

LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION

HS

**PORSCHE**

COMBUSTION AND EXHAUST EMISSION OF ENGINE USING THE PORSCHE-STRATIFIED-CHAMBER-SYSTEM

HS

**POTENTIAL**

STUDY OF POTENTIAL FOR MOTOR VEHICLE ECONOMY IMPROVEMENT. TECHNOLOGY REPORT

HS

THE STAGED COMBUSTION COMPOUND CYCLE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL

HS

**POWER**

ALTERNATIVE POWER SOURCES FOR LOW EMISSION AUTOMOBILES

HS

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

HS

**PRACTICE**

EUROPEAN PRACTICE IN RESPECT OF AUTOMATIC CAMS AND FOLLOWERS

HS

**PREDICTION**

PREDICTION OF RADIATIVE HEAT FLUXES IN DIESEL ENGINE

HS

**PRESENCE**

RESPONSE OF NAIVE DRIVERS TO PRESENCE OF STOP SIGNALS OF EXPERIMENTAL REAR LIGHT CONFIGURATIONS

HS

**PRESSURE**

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS

**PREVENTION**

AN EVALUATION OF EPIDEMIOLOGIC STUDIES RELATED TO ACCIDENT PREVENTION

HS

THE PREVENTION OF DANGEROUS BEHAVIOR: PREVENTION BY SELECTION: AN UNSUCCESSFUL APPROACH

HS

76-09

September 30, 1976

**PRIORITIES**

PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES

HS-018 603

HS-018 51

**PROCEDURES**

TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES

HS-018 513

HS-018 52

**PROGRAMMING**

IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT

HS-018 462

HS-018 52

**PROJECTS**

HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT

HS-018 487

STATISTICAL EVALUATION OF THE EFFECTIVENESS OF "ALCOHOL SAFETY ACTION PROJECTS"

HS-018 459

HS-018 89

**PROPERTY**

SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE, 1971

HS-018 605

HS-018 55

SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JULY THROUGH DECEMBER 1972

HS-018 608

HS-018 54

SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE 1973

HS-018 609

HS-018 52

SELECTED SAFETY ROAD CHECKS. MOTOR CARRIERS OF PROPERTY. 1970

HS-018 606

HS-018 52

**PROTECTION**

ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION

HS-018 509

HS-018 51

OCCUPANT PROTECTION IN VEHICLE ROLLOVER

HS-018 483

HS-018 45

**PUBLIC**

AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)

HS-018 881

HS-018 57

TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)

HS-018 461

HS-018 45

**PULL**

DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES

HS-018 492

HS-018 4

**PUMP**

A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS

HS-018 4

EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP

HS-018 52

**PUMPS**

CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION

HS-018 52

**PURSUANT**

THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973

HS-018 89

**QUALITIES**

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 55

**QUESTIONED**

SAFETY OF CATALYTIC CONVERTER QUESTIONED

HS-018 54

**RADIAL**

EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP

HS-018 52

THE OPERATION OF ELASTOMERIC RADIAL LINEAR SEALS AT HIGH TEMPERATURES

HS-018 52

**RADIATIVE**

PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE

HS-018 51

**RATES**

FATAL AND INJURY ACCIDENT RATES OF FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1971

HS-018 57

TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS

HS-018 45

**REALISTIC**

DRIVING SIMULATOR DESIGN FOR REALISTIC HANDLING

HS-018 52

**REAR**

INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)

HS-018 4

RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS

HS-018 4

STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT	HS-018 474	REQUIREMENT MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES	HS-018 634
RECALL MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS	HS-801 848	ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES	HS-018 633
RECIRCULATION THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2	HS-018 636	RESERVOIR HYDRAULIC RESERVOIR BREATHERS. HOW GOOD	HS-018 540
REEDUCATION REEDUCATION AND REHABILITATION OF THE DRUNKEN DRIVER	HS-018 620	RESPECT EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS	HS-018 578
REFERRAL ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6	HS-801 888	RESPONSE COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN	HS-018 611
REGULATIONS SNOWMOBILE HANDBOOK. LAWS AND REGULATIONS	HS-018 506	DRIVER RESPONSE TO VOLUNTARY AND MANDATORY SPEED LIMITS	HS-018 567
REHABILITATION AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6	HS-801 885	RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477
AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 883	RESTRAINT AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510
ANALYSES OF DRINKER DIAGNOSIS AND REFERRAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6	HS-801 888	THE 1974 RESTRAINT SYSTEMS: AN EVALUATION	HS-018 599
REEDUCATION AND REHABILITATION OF THE DRUNKEN DRIVER	HS-018 620	RIDE THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE	HS-018 617
RELATE A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES	HS-018 592	RING AN INVESTIGATION INTO PISTON RING SCUFFING DURING RUNNING-IN	HS-018 539
RELATIVE PERCEPTION OF RELATIVE VELOCITY	HS-018 478	RINGS NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE	HS-018 494
REMEDIAL REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES	HS-018 565	RISK ALCOHOL, DRUGS AND ACCIDENT RISK	HS-018 604
REPAIR AUTOMOTIVE DIAGNOSTIC AND REPAIR EQUIPMENT	HS-018 631	RISK TAKING AS A DECISION PROCESS IN DRIVING	HS-018 512
ROADSIDE IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT	HS-018 462		
PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES	HS-018 603		
ROADSIDE SAFETY DESIGN	HS-018 480		

September 30, 1976

**ROLLOVER**

OCCUPANT PROTECTION IN VEHICLE ROLLOVER  
HS-018 483

**RUNNING**

AN INVESTIGATION INTO PISTON RING SCUFFING  
DURING RUNNING-IN  
HS-018 539

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE  
DETECTION AS A FUNCTION OF HEADLIGHT USE  
AND AMBIENT ILLUMINATION  
HS-018 593

**SAFE**

HOW SAFE AT ANY SPEED? A CRITICAL LOOK AT  
TEN YEARS PROGRESS IN CAR SAFETY  
HS-018 610

**SAVE**

THE PRO AND CON OF MOTORCYCLE HELMET  
LAWS. HELMET LAWS SAVE LIVES  
HS-018 616

**SCANDINAVIAN**

BLOOD ALCOHOL CONCENTRATIONS AMONG  
SCANDINAVIAN DRIVERS: DATA FROM THE  
NORTHERN COUNTRIES IN INTERNATIONAL PER-  
SPECTIVE  
HS-018 625

**SCCE**

THE STAGED COMBUSTION COMPOUND ENGINE  
(SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY  
POTENTIAL  
HS-018 622

**SCHEDULING**

SCHEDULING DELAYS IN SYNCHRONOUS TRANS-  
PORTATION NETWORKS  
HS-018 550

**SCHOOL**

AN ANALYSIS OF THE LOS ANGELES UNIFIED  
SCHOOL DISTRICT COUNTERMEASURE: FINAL RE-  
PORT (LOS ANGELES COUNTY ALCOHOL SAFETY  
ACTION PROJECT)  
HS-801 884

**SCRAPERS**

DESIGN CONCEPTS OF THE 400 SERIES SCRAPERS  
HS-018 516

**SCUFFING**

AN INVESTIGATION INTO PISTON RING SCUFFING  
DURING RUNNING-IN  
HS-018 539

**SEALS**

NON-WEARING FERROFLUIDIC SEALS  
HS-018 537

THE OPERATION OF ELASTOMERIC RADIAL LIP  
SEALS AT HIGH TEMPERATURES  
HS-018 528

WHAT'S NEW WITH SEALS?  
HS-018 538

**SEAT**

A REVIEW OF THREE STUDIES ATTEMPTING TO RE-  
LATE REPORTED SEAT BELT USAGE TO SEAT BELT  
ATTITUDES AND OTHER VARIABLES  
HS-018 592

ESTIMATES OF MOTOR VEHICLE SEAT BELT EF-  
FECTIVENESS AND USE: IMPLICATIONS FOR OCCU-  
PANT CRASH PROTECTION  
HS-018 509

PRACTICAL AND MEDICAL ASPECTS OF THE USE  
OF CAR SEAT BELTS. TENTATIVE VIEWS FROM  
RECENT RESEARCH BY THE INSTITUTE FOR ROAD  
SAFETY RESEARCH SWOV  
HS-018 544

**SEMITRAILER**

OSCILLATORY INSTABILITY OF A TRACTOR-  
SEMITRAILER VEHICLE--A CASE STUDY  
HS-018 547

**SENSITIVE**

LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW  
APPROACH  
HS-018 525

**SENSITIVITY**

FILTER SELECTION BASED ON COMPONENT SEN-  
SITIVITY ANALYSIS  
HS-018 535

**SENSORS**

CHARACTERIZATION OF ZIRCONIA AND TITANIA  
ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL  
FEEDBACK CONTROL SYSTEMS  
HS-018 640

**SERIES**

DESIGN CONCEPTS OF THE 400 SERIES SCRAPERS  
HS-018 516

**SERVICE**

AN ANALYSIS OF THE OCCUPATIONAL HEALTH  
SERVICE COUNTERMEASURE: FINAL REPORT (LOS  
ANGELES COUNTY ALCOHOL SAFETY ACTION  
PROJECT)  
HS-801 882

SERVICE AND METHODS DEMONSTRATION (URBAN  
TRANSPORTATION). ANNUAL REPORT  
HS-018 484

**SIGNALING**

STUDIES OF AUTOMOBILE AND TRUCK REAR  
LIGHTING AND SIGNALING SYSTEMS. FINAL RE-  
PORT  
HS-018 474

**SIGNALS**

INTERPRETATION OF SIGNALS (VEHICLE REAR  
LIGHTING)  
HS-018 476

RESPONSE OF NAIVE DRIVERS TO PRESENCE AND  
STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING  
CONFIGURATIONS  
HS-018 477

**SIGNING**

INNOVATIVE TRAFFIC SIGNING: AN ON-SITE AP-  
PLICATION OF CURVED MARKERS  
HS-018 472

<b>SIMULATED</b>		<b>SPEED</b>	
MARIHUANA: EFFECTS OF SIMULATED DRIVING		ANNUAL SPEED STUDY (ARIZONA)	
PERFORMANCE	HS-018 458		HS-018 469
<b>SIMULATION</b>		DRIVER RESPONSE TO VOLUNTARY AND MANDA-	
CHARACTERIZATION AND SIMULATION OF A UNIT		TORY SPEED LIMITS	HS-018 567
INJECTOR	HS-018 514	HOW SAFE AT ANY SPEED? A CRITICAL LOOK AT	
SIMULATION OF VEHICLE BRAKING WITH ANTI-		TEN YEARS PROGRESS IN CAR SAFETY	HS-018 610
LOCK DEVICES	HS-018 552		
<b>SIMULATOR</b>		<b>STABILITY</b>	
DRIVING SIMULATOR DESIGN FOR REALISTIC		DIRECT AND INDIRECT METHODS FOR STABILITY	
HANDLING	HS-018 554	STUDIES OF ARTICULATED VEHICLES	HS-018 549
<b>SITE</b>		PARAMETER STUDY OF THE STABILITY OF AN AR-	
INNOVATIVE TRAFFIC SIGNING: AN ON-SITE AP-		TICULATED VEHICLE IN FIVE DEGREES OF	
PLICATION OF CURVED MARKERS	HS-018 472	INFORMATION	HS-018 548
<b>SIZE</b>		<b>STAGED</b>	
THE INFLUENCE OF FORWARD VISION AND TAR-		THE STAGED COMBUSTION COMPOUND ENGINE	
GET SIZE ON APPARENT INTER-VEHICULAR SPAC-		(SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY	
ING	HS-018 607	POTENTIAL	HS-018 622
<b>SLIP</b>		<b>STARTING</b>	
DETERMINATION OF ADHESIVE PARAMETERS		STARTING SYSTEMS (FOR TRUCKS): THE BIG	
CHARACTERIZING THE INTERACTION OF PNEU-		BREAKTHROUGH	HS-018 563
MATIC TIRES AND CONCRETE PAVEMENT FROM			
PULL-SLIP CURVES	HS-018 492	<b>STATES</b>	
<b>SMOKE</b>		THE NATIONAL HIGHWAY SAFETY NEEDS REPORT.	
A NEW DIESEL INJECTION PUMP WITH HIGH IN-		REPORT OF THE SECRETARY OF TRANSPORTATION	
JECTION RATE, ITS INFLUENCE ON SMOKE AND		TO THE UNITED STATES CONGRESS PURSUANT TO	
EMISSIONS	HS-018 515	SECTION 225 OF THE HIGHWAY SAFETY ACT OF	
<b>SNOW</b>		1973	
HANDLING YOUR CAR ON ICE AND SNOW	HS-018 628	<b>STATIC</b>	
		A LASER INTERFEROMETER STUDY OF COM-	
		BUSTION NEAR AN IGNITION SOURCE IN A STATIC	
		CHAMBER	HS-018 589
<b>SNOWMOBILE</b>		<b>STATISTICAL</b>	
SNOWMOBILE HANDBOOK. LAWS AND REGULA-		A CRITIQUE OF THE PAPER "STATISTICAL	
TIONS	HS-018 506	EVALUATION OF THE EFFECTIVENESS OF AL-	
		COHOL SAFETY ACTION"	HS-018 460
<b>SPACING</b>		STATISTICAL EVALUATION OF THE EFFECTIVE-	
THE INFLUENCE OF FORWARD VISION AND TAR-		NESS OF "ALCOHOL SAFETY ACTION PROJECTS"	HS-018 459
GET SIZE ON APPARENT INTER-VEHICULAR SPAC-			
ING	HS-018 607	<b>STEERING</b>	
<b>SPARK</b>		LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW	
EUROPEAN OILS FOR SPARK IGNITION ENGINES	HS-018 566	APPROACH	HS-018 525
TURBULENT FLOW IN SPARK IGNITION ENGINE		LOOK AHEAD STEERING STRATEGY	HS-018 555
COMBUSTION CHAMBERS	HS-018 587		
<b>SPECIALIZED</b>		<b>STOP</b>	
OPTIMAL AERO-MECHANICAL DESIGN FOR SPE-		RESPONSE OF NAIVE DRIVERS TO PRESENCE AND	
CIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE		STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING	
SYSTEMS	HS-018 556	CONFIGURATIONS	HS-018 477
<b>STRATEGY</b>			
LOOK AHEAD STEERING STRATEGY			
			HS-018 555

September 30, 1976

**STRATIFIED**

COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM

HS-018 590

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

STRATIFIED CHARGE ENGINES. FINAL REPORT  
HS-018 613

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

**STRESS**

COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS

HS-018 582

**STROKE**

FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS

HS-018 521

**STRUCTURAL**

AEROSPACE STRUCTURAL ADHESIVES. FINAL REPORT

HS-018 473

**STRUCTURES**

COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS

HS-018 582

**STUDDED**

EFFECTS OF STUDDED TIRES

HS-018 614

**SUBMERGED**

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 557

**SURVEYS**

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS

HS-801 894

**SUSPENSION**

THE APPLICATION OF AN ELECTROVISCOUS DAMPER TO A VEHICLE SUSPENSION SYSTEM

HS-018 551

**SUSPENSIONS**

HEAVY-DUTY TRUCK SUSPENSIONS

HS-018 600

**SWOV**

PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

HS-018 544

**SYNCHRONOUS**

SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS

HS-018 550

**SYNTHETIC**

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

HS-018 532

VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS

HS-018 531

**SYSTEMS/**

FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974

HS-018 570

**TAILLIGHTS**

AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA

HS-018 630

**TARGET**

THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING

HS-018 607

**TECHNIQUE**

SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL

HS-018 498

**TEENAGE**

FAMILY DISORGANIZATION AND TEENAGE AUTO ACCIDENTS

HS-018 471

**TEMPERATURE**

AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT

HS-018 564

EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL

HS-018 527

LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION

HS-018 577

**TEMPERATURES**

TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES

HS-018 545

THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES

HS-018 528

**TENNESSEE**

BICYCLING IN TENNESSEE. INVENTORY OF USERS, FACILITIES, AND PROGRAMS

HS-018 602

**TENTATIVE**

PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

HS-018 544

**TESTING**

PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE

HS-018 559

SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL

HS-018 498

TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)

HS-018 461

**THERMAL**

COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS

HS-018 582

**TIRE**

A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING

HS-018 553

EXPERIMENTAL VALIDATION OF THE CALSPAN TIRE RESEARCH FACILITY. VOL. 1. FINAL REPORT

HS-018 481

FIGHTING FRONT TIRE FAILURES

HS-018 573

IF THE TIRE FITS, BUY IT

HS-018 569

PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT

HS-018 541

TIRE DESIGNS FOR MOBILITY--USSR

HS-018 493

**TIRES**

DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEUMATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES

HS-018 492

EFFECTS OF STUDDED TIRES

HS-018 614

**TITANIA**

CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

HS-018 640

**TRACTOR**

OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY

HS-018 547

**TRAFFIC**

AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES

OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA

HS-018 629

EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS

HS-018 468

HANDLING TRAFFIC CASES: A BETTER WAY

HS-018 490

HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT

HS-018 487

INNOVATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS

HS-018 472

INVESTIGATIONS INTO LIGHT TRAFFIC 2

HS-018 495

TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS

HS-018 457

WHY TRAFFIC CONTROL IS A MUST\*

HS-018 627

**TRAIN**

EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST

HS-018 579

**TRANSBUS**

TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)

HS-018 461

**TRANSDUCERS**

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS-018 585

**TRANSFER**

CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

**TRANSMISSION**

APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS

HS-018 532

**TRANSPORTATION**

ENERGY AND TRANSPORTATION

HS-018 595

SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS

HS-018 550

SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT

HS-018 484

THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973

HS-801 892

September 30, 1976

**TREATMENT**

REMEDIAL SAFETY TREATMENT OF NARROW  
BRIDGES

HS-018 565

**TRUCK**

HEAVY-DUTY TRUCK SUSPENSIONS

HS-018 600

STUDIES OF AUTOMOBILE AND TRUCK REAR  
LIGHTING AND SIGNALING SYSTEMS. FINAL RE-  
PORT

HS-018 474

**TRUCKS**

STARTING SYSTEMS (FOR TRUCKS): THE BIG  
BREAKTHROUGH

HS-018 563

**TUBE**

CORRECTION FACTOR TO UNIT CORE HEAT  
TRANSFER CAPABILITY OF HEAT EXCHANGER  
CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

**TURBULENCE**

THE MEASUREMENT OF THE TURBULENCE  
CHARACTERISTICS IN AN INTERNAL COMBUSTION  
ENGINE CYLINDER

HS-018 588

**TURBULENT**

TURBULENT FLOW IN SPARK IGNITION ENGINE  
COMBUSTION CHAMBERS

HS-018 587

**ULTIMATE**

AN ANALYSIS OF ULTIMATE PERFORMANCE MEA-  
SURES: 1974 (LOS ANGELES COUNTY ALCOHOL  
SAFETY ACTION PROJECT)

HS-801 877

**UNIFIED**

AN ANALYSIS OF THE LOS ANGELES UNIFIED  
SCHOOL DISTRICT COUNTERMEASURE: FINAL RE-  
PORT (LOS ANGELES COUNTY ALCOHOL SAFETY  
ACTION PROJECT)

HS-801 884

**UNIT**

CHARACTERIZATION AND SIMULATION OF A UNIT  
INJECTOR

HS-018 514

CORRECTION FACTOR TO UNIT CORE HEAT  
TRANSFER CAPABILITY OF HEAT EXCHANGER  
CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

**UNSUCCESSFUL**

THE PREVENTION OF DANGEROUS BEHAVIOUR. 1.  
PREVENTION BY SELECTION: AN UNSUCCESSFUL  
APPROACH

HS-018 543

**URBAN**

PRACTICAL OPERATION AND TESTING OF AN  
URBAN ELECTRIC VEHICLE

HS-018 559

SERVICE AND METHODS DEMONSTRATION (URBAN  
TRANSPORTATION). ANNUAL REPORT

HS-018 484

**USAGE**

A REVIEW OF THREE STUDIES ATTEMPTING TO RE-  
LATE REPORTED SEAT BELT USAGE TO SEAT BELT  
ATTITUDES AND OTHER VARIABLES

HS-018 592

AN INVESTIGATION TO DETERMINE WHETHER  
THE DAYTIME USAGE OF MOTORCYCLE  
HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE  
COMPULSORY IN WESTERN AUSTRALIA

HS-018 630

**USERS**

BICYCLING IN TENNESSEE. INVENTORY OF USERS,  
FACILITIES, AND PROGRAMS

HS-018 602

**USES**

BREATH-ALCOHOL ANALYSIS: USES, METHODS,  
AND SOME FORENSIC PROBLEMS--REVIEW AND  
OPINION

HS-018 621

**USSR**

TIRE DESIGNS FOR MOBILITY--USSR

HS-018 493

**VALIDATION**

EXPERIMENTAL VALIDATION OF THE CALSPAN  
TIRE RESEARCH FACILITY. VOL. 1. FINAL REPORT

HS-018 481

**VALVE**

EUROPEAN VALVE TRAIN WEAR--SOME EX-  
PERIENCE WITH THE VOLVO B20 TEST

HS-018 579

THE EFFECT OF BY-PASS VALVE LEAKAGE ON  
FILTER PERFORMANCE

HS-018 534

**VANS**

DRIVER SAFETY IN MODIFIED VANS

HS-018 591

**VARIABLE**

CONTROLLING VARIABLE DISPLACEMENT  
HYDRAULIC PUMPS FOR ENERGY CONSERVATION

HS-018 526

**VARIABLES**

A REVIEW OF THREE STUDIES ATTEMPTING TO RE-  
LATE REPORTED SEAT BELT USAGE TO SEAT BELT  
ATTITUDES AND OTHER VARIABLES

HS-018 592

MORE DATA ON ORI (OCTANE REQUIREMENT IN-  
CREASE) VARIABLES

HS-018 634

THE EFFECTS OF ENGINE VARIABLES AND EX-  
HAUST GAS RECIRCULATION ON EMISSIONS, FUEL  
ECONOMY, AND KNOCK--PART 2

HS-018 636

**VARIATION**

CORRECTION FACTOR TO UNIT CORE HEAT  
TRANSFER CAPABILITY OF HEAT EXCHANGER  
CORE DUE TO VARIATION OF TUBE LENGTH

HS-018 586

**VDI**

CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230

HS-018 584

**VEHICLE**

A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING

HS-018 553

AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT

HS-018 564

DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION

HS-018 593

EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE

HS-018 624

ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION

HS-018 509

INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974

HS-018 546

INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)

HS-018 476

LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES

HS-018 560

MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS

HS-801 848

OCCUPANT PROTECTION IN VEHICLE ROLLOVER

HS-018 483

OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS

HS-018 556

OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY

HS-018 547

PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM

HS-018 548

PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE

HS-018 559

SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES

HS-018 552

STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT

HS-018 464

TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES

HS-018 513

TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE

HS-018 557

THE APPLICATION OF AN ELECTROVISCOUS DAMPER TO A VEHICLE SUSPENSION SYSTEM

HS-018 551

VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS

HS-018 531

**VEHICLES**

DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES

HS-018 549

NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU

HS-018 491

ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES

HS-018 633

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

**VEHICULAR**

THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING

HS-018 607

**VELOCITY**

PERCEPTION OF RELATIVE VELOCITY

HS-018 478

**VERSATILITY**

EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP

HS-018 524

**VIEWS**

PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

HS-018 544

**VIRGINIA**

INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974

HS-018 546

**VISCOSITY**

LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION

HS-018 577

TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES

HS-018 545

September 30, 1976

**VISIBLE**

NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES

HS-018 503

**VISION**

THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING

HS-018 607

**VOLKSWAGEN**

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

**VOLUNTARY**

DRIVER RESPONSE TO VOLUNTARY AND MANDATORY SPEED LIMITS

HS-018 567

**VOLVO**

EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST

HS-018 579

**WASHER**

INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS

HS-018 585

**WASHINGTON**

WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION

HS-018 623

**WATER**

PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER

HS-018 635

THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE

HS-018 580

**WEAR**

EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST

HS-018 579

THE NATURE OF ABRASIVE WEAR

HS-018 530

**WEARING**

NON-WEARING FERROFLUIDIC SEALS

HS-018 537

**WESTERN**

AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA

HS-018 629

AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA

HS-018 630

**WHEEL**

V DRIVE (NEW FOUR WHEEL DRIVE SYSTEM)

HS-018 568

**WHITEHEAD**

COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.

HS-018 615

**WIPEOUT**

BEATING THE OBLLOWOUT WIPEOUT'

HS-018 576

**YORK**

NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU

HS-018 491

**YOUNG**

COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN

HS-018 611

COLLISION BEHAVIOR OF YOUNG DRIVERS. COMMENT ON THE STUDY BY WHITEHEAD ET AL.

HS-018 615

**ZIRCONIA**

CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS

HS-018 640

**ZYLMAN**

COLLISION BEHAVIOR OF YOUNG DRIVERS. A RESPONSE TO ZYLMAN

HS-018 611



## Author Index

<b>Abe, S.</b> NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT	HS-018 637	<b>Beshai, Nabila N.</b> AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
		HS-018 879
<b>Anderson, R. D.</b> NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE	HS-018 494	AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)
		HS-018 882
<b>Anson, James H.</b> WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)	HS-018 529	<b>Bisimis, E.</b> OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY
		HS-018 547
<b>Antonucci, A.</b> A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS	HS-018 515	<b>Boekhaus, K. L.</b> PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER
		HS-018 635
<b>Armstrong, Ed</b> THE PRO AND CON OF MOTORCYCLE HELMET LAWS. IF YOU RIDE, YOU DECIDE	HS-018 617	<b>Bohuslav, Ben</b> REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES
		HS-018 565
<b>Atkins, Joe F.</b> TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)	HS-018 461	<b>Borkenstein, Robert F.</b> DRINKING AND DRIVING IN OTHER LANDS
		HS-018 618
<b>Attwood, D. A.</b> DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION	HS-018 593	<b>Brandone, B.</b> FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS
		HS-018 521
<b>Avery, Howard S.</b> THE NATURE OF ABRASIVE WEAR	HS-018 530	<b>Brandstetter, W. R.</b> THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE
		HS-018 580
<b>Bahl, James M.</b> EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP	HS-018 524	<b>Brett, P. S.</b> AN INVESTIGATION INTO PISTON RING SCUFFING DURING RUNNING-IN
		HS-018 539
<b>Belati, M.</b> LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION	HS-018 577	<b>Bruce, R. W.</b> FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING
		HS-018 558
<b>Belytschko, T.</b> FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING	HS-018 558	<b>Brunelle, M. F.</b> EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE
		HS-018 624
<b>Benjamin, P.</b> SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484	<b>Brunke, Erwin C.</b> SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL
		HS-018 498
<b>Bensch, L. E.</b> LUBE OIL FILTER EVALUATION	HS-018 533	<b>Bullough, W. A.</b> THE APPLICATION OF AN ELECTROVISCOSUS DAMPER TO A VEHICLE SUSPENSION SYSTEM
		HS-018 551

<b>Burch, Helen E.</b> AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 884	<b>Curry, G. A.</b> TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES	HS-018 513
<b>Busetto, G. F.</b> TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES	HS-018 545	<b>Darby, R. E.</b> THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A. LITERATURE SUMMARY	HS-801 893
<b>Capello, G.</b> TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES	HS-018 545	<b>Decker, G.</b> THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE	HS-018 580
<b>Casewit, Curtis W.</b> HANDLING YOUR CAR ON ICE AND SNOW	HS-018 628	<b>Delosh, R. G.</b> LABORATORY EVALUATION OF THREE-WAY CATALYSTS	HS-018 639
<b>Casey, R.</b> SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484	<b>Dent, J. C.</b> THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER	HS-018 588
<b>Cederquist, A. L.</b> CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640	<b>DeJev, M. J.</b> FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS	HS-018 521
<b>Cheslow, Melvyn</b> INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROVING AUTOMOBILE FUEL EFFICIENCY: AN INPUT-OUTPUT ANALYSIS	HS-018 507	<b>Dickinson, J. E.</b> EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE	HS-018 624
<b>Chiou, Jiunn P.</b> CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586	<b>DiCesare, Frank</b> TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE	HS-018 557
<b>Cofield, C.</b> SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484	<b>Dubowski, K. M.</b> BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION	HS-018 621
<b>Collins, R. L.</b> A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING	HS-018 553	<b>Duffy, Robert E.</b> OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556
DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES	HS-018 549	TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE	HS-018 557
<b>Connell, William M.</b> ACCIDENT SOURCE COMPILATION. FINAL REPORT	HS-018 467	<b>Eccleston, B. H.</b> AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT	HS-018 564
<b>Copeland, L. C.</b> PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER	HS-018 635	<b>Edelman, A.</b> PRACTICAL AND MEDICAL ASPECTS OF THE USE OF CAR SEAT BELTS. TENTATIVE VIEWS FROM	
<b>Crow, James T.</b> IF THE TIRE FITS, BUY IT	HS-018 569		

September 30, 1976

RECENT RESEARCH BY THE INSTITUTE FOR ROAD SAFETY RESEARCH SWOV	HS-018 544	Fukuda, Mizuho COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS	HS-018 582
<b>Epperson, Dave</b> V DRIVE (NEW FOUR WHEEL DRIVE SYSTEM)	HS-018 568	<b>Fuller, Jackson F.</b> PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE	HS-018 559
<b>Evans, Leonard</b> THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING	HS-018 607	<b>Gadallah, Ahmed Atef</b> DRIVER RESPONSE TO VOLUNTARY AND MANDATORY SPEED LIMITS	HS-018 567
<b>Ezekiel, Frederick D.</b> NON-WEARING FERROFLUIDIC SEALS	HS-018 537	<b>Gandhi, H. S.</b> LABORATORY EVALUATION OF THREE-WAY CATALYSTS	HS-018 639
<b>Fine, Eric W.</b> UNDER THE INFLUENCE	HS-018 619	<b>Gibbons, E. F.</b> CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640
<b>Fish, Robert L.</b> EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL	HS-018 527	<b>Gibson, H. J.</b> ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE	HS-018 601
<b>Fisher, E. L.</b> EFFECTS OF THE MOTOR VEHICLE CONTROL PROGRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE	HS-018 624	<b>Giulio, U.</b> TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES	HS-018 545
<b>Fitch, E. C.</b> FILTER SELECTION BASED ON COMPONENT SENSITIVITY ANALYSIS	HS-018 535	<b>Gless, George E.</b> PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE	HS-018 559
<b>Fleischhack, G. C.</b> MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION	HS-018 522	<b>Gordon, D. A.</b> HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT	HS-018 487
<b>Flora, Jairus D.</b> AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510	<b>Goyal, A. K.</b> APPLIED PHOTOELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS	HS-018 583
THE 1974 RESTRAINT SYSTEMS: AN EVALUATION	HS-018 599	<b>Greene, Fred S.</b> ACCIDENT SOURCE COMPILATION. FINAL REPORT	HS-018 467
<b>Florendo, Ronald M.</b> AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 877	<b>Grotewohl, A.</b> CALCULATION OF A DYNAMICALLY AND ECCENTRICALLY LOADED BOLTED CONROD CONNECTION ACCORDING TO VDI 2230	HS-018 584
<b>Fortnagel, Manfred</b> DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE	HS-018 581	<b>Gruden, Dusan</b> COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM	HS-018 590
<b>Foxon, M. B.</b> THE APPLICATION OF AN ELECTROVISCOUS DAMPER TO A VEHICLE SUSPENSION SYSTEM	HS-018 551		
<b>Fraenkle, G.</b> NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES	HS-018 503		

Hall, Jerome Wm.		
IDENTIFICATION AND PROGRAMMING OF ROAD-SIDE HAZARD IMPROVEMENTS. INTERIM REPORT		
HS-018 462		HS-018 513
Halper, Andrew		
NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU		
HS-018 491		HS-018 475
Hardenberg, H. O.		
NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES		
HS-018 503		HS-018 476
Hare, Charles T.		
EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT		
HS-018 520		HS-018 477
Harvey, C. F.		
DRIVER ERROR		
HS-018 511		HS-018 478
Haugen, Ruth		
AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)		
HS-801 878		HS-018 532
Hauser, E. W.		
THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A: LITERATURE SUMMARY		
HS-801 893		HS-018 528
THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS		
HS-801 894		HS-018 458
Heaton, C.		
SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT		
HS-018 484		HS-018 520
Hegmon, R. R.		
PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT		
HS-018 541		HS-018 564
Henein, N. A.		
CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR		
HS-018 514		HS-018 587
Heron, Ruth M.		
A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES		
HS-018 592		HS-018 511
Hetrick, S. S.		
THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2		
HS-018 636		HS-018 460
Hieatt, D. J.		
TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES		
HS-018 513		HS-018 616
Hoffmann, E. R.		
ACCIDENT DATA ANALYSIS		
HS-018 475		
INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)		
HS-018 476		
PERCEPTION OF RELATIVE VELOCITY		
HS-018 477		
RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS		
HS-018 478		
STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT		
HS-018 479		
Hopler, P. D.		
APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS		
HS-018 532		
Horve, L. A.		
THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES		
HS-018 528		
Hulbert, Slade		
MARIHUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE		
HS-018 458		
Huls, Thomas A.		
EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT		
HS-018 520		
Hurn, R. W.		
AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT		
HS-018 564		
James, E. H.		
TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS		
HS-018 587		
Jenkins, D.		
DRIVER ERROR		
HS-018 511		
Johnson, Penelope		
A CRITIQUE OF THE PAPER "STATISTICAL EVALUATION OF THE EFFECTIVENESS OF ALCOHOL SAFETY ACTION"		
HS-018 460		
THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES		
HS-018 616		

September 30, 1976

<b>Jorgeson, C. M.</b>		<b>Komandi, G.</b>	
ACCIDENT DATA ANALYSIS	HS-018 475	DETERMINATION OF ADHESIVE PARAMETERS CHARACTERIZING THE INTERACTION OF PNEU- MATIC TIRES AND CONCRETE PAVEMENT FROM PULL-SLIP CURVES	HS-018 492
INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476		
PERCEPTION OF RELATIVE VELOCITY	HS-018 478		
RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477		
STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL RE- PORT	HS-018 474		
<b>Joscelyn, Kent B.</b>	HS-018 598	<b>Kondo, M.</b>	
THE ROLE OF OUR LEGAL SYSTEM IN INFLUENC- ING DRIVER BEHAVIOR		INDISCOPE--A NEW COMBUSTION PRESSURE IN- DICATOR WITH WASHER TRANSDUCERS	HS-018 585
<b>Kabel, Richard H.</b>			
VEHICLE EVALUATION OF SYNTHETIC AND CON- VENTIONAL ENGINE OILS	HS-018 531	<b>Kornhauser, Alain L.</b>	
		SCHEDULING DELAYS IN SYNCHRONOUS TRANS- PORTATION NETWORKS	HS-018 550
<b>Kaneko, Y.</b>			
NOX (OXIDES OF NITROGEN) CATALYTIC CON- VERTER DEVELOPMENT	HS-018 637	<b>Kuchinski, D. D.</b>	
		INNOVATIVE TRAFFIC SIGNING: AN ON-SITE AP- PLICATION OF CURVED MARKERS	HS-018 472
<b>Karhnak, John M. , Jr.</b>			
HYDRAULIC RESERVOIR BREATHERS. HOW GOOD	HS-018 540	<b>Kunitomo, Takeshi</b>	
		PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE	HS-018 518
<b>Keese, Charles J.</b>			
REMEDIAL SAFETY TREATMENT OF NARROW BRIDGES	HS-018 565	<b>Kuroda, Hiroshi</b>	
		STUDY OF NH3 (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638
<b>Keller, B. D.</b>			
ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES	HS-018 633	<b>Ladan, C. J.</b>	
		INNOVATIVE TRAFFIC SIGNING: AN ON-SITE AP- PLICATION OF CURVED MARKERS	HS-018 472
<b>Kendall, D.</b>			
SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484	<b>Larrabee, E. Eugene</b>	
		LOOK AHEAD STEERING STRATEGY	HS-018 555
<b>Kidder, H. E.</b>			
MORE DATA ON ORI (OCTANE REQUIREMENT IN- CREASE) VARIABLES	HS-018 634	<b>Laughland, J. C.</b>	
		THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A. LITERATURE SUMMARY	HS-801 893
<b>Knapp, B. G.</b>			
HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT	HS-018 487	<b>Laurell, Hans</b>	
		EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS	HS-018 468
<b>Kobayashi, H.</b>			
NOX (OXIDES OF NITROGEN) CATALYTIC CON- VERTER DEVELOPMENT	HS-018 637	<b>Lema, J. E.</b>	
		THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A. LITERATURE SUMMARY	HS-801 893
<b>Leonard, M. J.</b>			
EFFECTS OF THE MOTOR VEHICLE CONTROL PRO- GRAM ON HYDROCARBON CONCENTRATIONS IN THE CENTRAL LOS ANGELES ATMOSPHERE			
			HS-018 624

<b>Lestz, S. J.</b>	APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS	HS-018 532	<b>Matsuoka, Kazuo</b>	PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE	HS-018 518
<b>Levy, Paul</b>	A CRITIQUE OF THE PAPER "STATISTICAL EVALUATION OF THE EFFECTIVENESS OF ALCOHOL SAFETY ACTION"	HS-018 460	<b>Mayhew, D. J.</b>	NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE	HS-018 494
THE PRO AND CON OF MOTORCYCLE HELMET LAWS. HELMET LAWS SAVE LIVES	HS-018 616				
<b>Linnoila, M.</b>	TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS	HS-018 457	<b>McCormick, H. E.</b>	NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE	HS-018 494
<b>Lloyd, Frederick A.</b>	EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL	HS-018 527	<b>McDonnell, John</b>	NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU	HS-018 491
A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS	HS-018 515				
<b>Love, R. J.</b>	EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS	HS-018 578	<b>McEvaddy, Patrick J.</b>	SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS	HS-018 550
<b>Lucas, G. G.</b>	TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS	HS-018 587	<b>McGlothlin, William H.</b>	MARIJUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE	HS-018 458
TRAFFIC ACCIDENT RATES AMONG FINNISH OUT-PATIENTS	HS-018 457				
<b>Maki, M.</b>	REEDUCATION AND REHABILITATION OF THE DRUNKEN DRIVER	HS-018 620	<b>McGrath, James J.</b>	DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS	HS-018 596
TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE	HS-018 557				
<b>Malfetti, James L.</b>	AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510	<b>McIntire, John R.</b>	AN ANALYSIS OF LAW ENFORCEMENT COUNTER-MEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 880
THE 1974 RESTRAINT SYSTEMS: AN EVALUATION	HS-018 599				
<b>Manning, Robert W.</b>	BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION	HS-018 621	<b>Meguerian, G. H.</b>	ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES	HS-018 633
AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510				
<b>Marsh, Joseph C.</b>	SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484	<b>Meitzler, A. H.</b>	CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS	HS-018 640
THE 1974 RESTRAINT SYSTEMS: AN EVALUATION	HS-018 599				
<b>Mason, M. F.</b>	THE PREVENTION OF DANGEROUS BEHAVIOUR. 1. PREVENTION BY SELECTION: AN UNSUCCESSFUL APPROACH	HS-018 543	<b>Michon, John A.</b>		
BREATH-ALCOHOL ANALYSIS: USES, METHODS, AND SOME FORENSIC PROBLEMS--REVIEW AND OPINION	HS-018 621				
<b>Miller, Emanda B.</b>	AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	HS-801 881			
<b>Misner, J.</b>	SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484			

September 30, 1976

<b>Mitschke, M.</b> SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES	HS-018 552	<b>Moskowitz, Ronald</b> NON-WEARING FERROFLUIDIC SEALS	HS-018 537
<b>Moncarz, Howard T.</b> PARAMETER STUDY OF THE STABILITY OF AN ARTICULATED VEHICLE IN FIVE DEGREES OF FREEDOM	HS-018 548	<b>Mulligan, Michael</b> UNDER THE INFLUENCE	HS-018 619
<b>Montanari, V.</b> A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS	HS-018 515	<b>Myers, Allen</b> CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION	HS-018 526
<b>Moore, C. D.</b> ACCIDENT DATA ANALYSIS	HS-018 475	<b>Nader, Ralph</b> WASHINGTON UNDER THE INFLUENCE: A TEN YEAR REVIEW OF AUTO SAFETY AMIDST INDUSTRIAL OPPOSITION	HS-018 623
INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476	<b>Nagai, Tadashi</b> STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638
PERCEPTION OF RELATIVE VELOCITY	HS-018 478	<b>Nakajima, Yasuo</b> STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638
RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477	<b>Nakamura, T.</b> INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS	HS-018 585
STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT	HS-018 474	<b>Nelson, T. M.</b> INNOVATIVE TRAFFIC SIGNING: AN ON-SITE APPLICATION OF CURVED MARKERS	HS-018 472
<b>Morgan, C. R.</b> THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2	HS-018 636	<b>Newsome, L. R.</b> RISK TAKING AS A DECISION PROCESS IN DRIVING	HS-018 512
<b>Morris, P. R.</b> EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	HS-018 523	<b>Nightingale, David R.</b> A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES	HS-018 536
<b>Mortimer, R. G.</b> ACCIDENT DATA ANALYSIS	HS-018 475	<b>Niimi, A.</b> INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS	HS-018 585
INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476	<b>Oblander, Kurt</b> DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE	HS-018 581
PERCEPTION OF RELATIVE VELOCITY	HS-018 478	<b>Oguri, Takeji</b> STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638
RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477	<b>Oguri, Tatsu</b> PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE	HS-018 518
STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT	HS-018 474		
<b>Moskowitz, Herbert</b> MARIJUANA: EFFECTS OF SIMULATED DRIVING PERFORMANCE	HS-018 458		

<b>Ohinouye, T.</b>	NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT	HS-018 637	RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477
<b>Olson, P. L.</b>	ACCIDENT DATA ANALYSIS	HS-018 475	STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT	HS-018 474
	INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476		
	PERCEPTION OF RELATIVE VELOCITY	HS-018 478		
	RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477		
	STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL REPORT	HS-018 474		
<b>Oranen, Liisa</b>	INVESTIGATIONS INTO LIGHT TRAFFIC 2	HS-018 495		
<b>Osada, Kazuo</b>	COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS	HS-018 582		
<b>Pachernegg, S. J.</b>	EFFICIENT AND CLEAN DIESEL COMBUSTION	HS-018 519		
<b>Pedrys, F. J.</b>	MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES	HS-018 634		
<b>Peters, J. I.</b>	HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT	HS-018 487		
<b>Piken, A. G.</b>	LABORATORY EVALUATION OF THREE-WAY CATALYSTS	HS-018 639		
<b>Pilkey, Walter D.</b>	LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES	HS-018 560		
<b>Popish, Lloyd N.</b>	CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?	HS-018 465		
<b>Poskocil, A.</b>	ACCIDENT DATA ANALYSIS	HS-018 475		
	INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476		
	PERCEPTION OF RELATIVE VELOCITY	HS-018 478		
<b>Rau, J. L.</b>	LOAD-SENSITIVE HYDROSTATIC STEERING--A NEW APPROACH			HS-018 525
<b>Reichel, K.</b>	THE WATER-COOLED VOLKSWAGEN PCI-STRATIFIED CHARGE ENGINE			HS-018 580
<b>Rivolo, P. F.</b>	A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS			HS-018 515
<b>Robertson, Leon S.</b>	ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION			HS-018 509
	PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES			
<b>Rodgers, John J.</b>	VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS			HS-018 531
<b>Romslo, Floyd</b>	AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6			HS-801 885
<b>Roper, William L.</b>	SAFETY OF CATALYTIC CONVERTER QUESTIONED			HS-018 542
	WHY TRAFFIC CONTROL IS A MUST			HS-018 627
<b>Roper, Wm. L.</b>	THE HIGHWAY KILLER-COMBINATION			HS-018 482
<b>Rosen, Stuart D.</b>	AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6			HS-801 885
<b>Ross, H. Laurence</b>	BLOOD ALCOHOL CONCENTRATIONS AMONG SCANDINAVIAN DRIVERS: DATA FROM THE NORTHERN COUNTRIES IN INTERNATIONAL PERSPECTIVE			HS-018 625

September 30, 1976

<b>Rotheny, Richard</b> THE INFLUENCE OF FORWARD VISION AND TARGET SIZE ON APPARENT INTER-VEHICULAR SPACING	HS-018 607	<b>Scoles, Pascal</b> UNDER THE INFLUENCE	HS-018 619
<b>Roux, F.</b> EUROPEAN OILS FOR SPARK IGNITION ENGINES	HS-018 566	<b>Scott, Charles M.</b> DRIVER SAFETY IN MODIFIED VANS	HS-018 591
<b>Rozanski, J.</b> CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR	HS-018 514	<b>Scott, Robert E.</b> AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510
<b>Rulison, M. ve.</b> THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894	<b>THE 1974 RESTRAINT SYSTEMS: AN EVALUATION</b>	HS-018 599
<b>Runt, L. J.</b> PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT	HS-018 541	<b>Shelef, M.</b> LABORATORY EVALUATION OF THREE-WAY CATALYSTS	HS-018 639
<b>Rychlewski, W. J.</b> NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE	HS-018 494	<b>Shepler, Paul R.</b> SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	HS-018 498
<b>Sachs, H. K. , ed.</b> INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974	HS-018 546	<b>Siewert, Robert M.</b> THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL	HS-018 622
<b>Sadler, Judy</b> CHILDREN AND ROAD SAFETY: A SURVEY AMONGST MOTHERS	HS-018 597	<b>Simkowitz, H.</b> SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT	HS-018 484
<b>Saillant, R. B.</b> MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES	HS-018 634	<b>Singh, T.</b> CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR	HS-018 514
<b>Saito, Tsuneaki</b> STUDY OF NH3 (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM	HS-018 638	<b>Slater, B. B.</b> EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST	HS-018 579
<b>Salama, N. S.</b> THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER	HS-018 588	<b>Smith, D. I.</b> AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA	HS-018 629
<b>Scannell, John B.</b> WHAT'S NEW WITH SEALS?	HS-018 538	<b>AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA</b>	HS-018 630
<b>Schaeffer, Monica H.</b> AN EVALUATION OF EPIDEMIOLOGIC STUDIES RELATED TO ACCIDENT PREVENTION	HS-018 470	<b>Smith, J. B.</b> ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES	HS-018 633
<b>Sobel, Raymond</b> FAMILY DISORGANIZATION AND TEENAGE AUTO ACCIDENTS			HS-018 471

<b>Spelten, Hermann</b>		
HYDRAULIC RESERVOIR BREATHERS. HOW GOOD		
	HS-018 540	
<b>Springer, Karl J.</b>		
EXHAUST EMISSIONS FROM FARM, CONSTRUC-		
TION, AND INDUSTRIAL ENGINES AND THEIR IM-		
PACT		HS-018 589
	HS-018 520	
<b>Steffen, Ronald W.</b>		
WHAT ARE THE BENEFITS OF MONITORING?		
(ELECTRONIC MONITORING EQUIPMENT FOR		
AGRICULTURAL USE)		
	HS-018 529	
<b>Sternberg, E. R.</b>		
HEAVY-DUTY TRUCK SUSPENSIONS		
	HS-018 600	
<b>Stone, John G.</b>		
WHAT'S NEW WITH SEALS?		
	HS-018 538	
<b>Stone, K.</b>		
OCCUPANT PROTECTION IN VEHICLE ROLLOVER		
	HS-018 483	
<b>Strenkowski, John S.</b>		
LIMITING PERFORMANCE CHARACTERISTICS OF		
VEHICLE IMPACT SAFETY DEVICES		
	HS-018 560	
<b>Sumner, R.</b>		
DRIVER ERROR		
	HS-018 511	
<b>Teo, Richard K. C.</b>		
ALCOHOL, DRUGS AND ACCIDENT RISK		
	HS-018 604	
<b>Tessman, R. K.</b>		
THE EFFECT OF BY-PASS VALVE LEAKAGE ON		
FILTER PERFORMANCE		
	HS-018 534	
<b>Tracy, C. B.</b>		
ORI (OCTANE REQUIREMENT INCREASE) OF		
TODAY'S VEHICLES		
	HS-018 633	
<b>Turns, Stephen R.</b>		
THE STAGED COMBUSTION COMPOUND ENGINE		
(SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY		
POTENTIAL		
	HS-018 622	
<b>Underhill, Ralph</b>		
FAMILY DISORGANIZATION AND TEENAGE AUTO		
ACCIDENTS		
	HS-018 471	
<b>Van Kampen, L. T. B.</b>		
PRACTICAL AND MEDICAL ASPECTS OF THE USE		
OF CAR SEAT BELTS. TENTATIVE VIEWS FROM		
RECENT RESEARCH BY THE INSTITUTE FOR ROAD		
SAFETY RESEARCH SWOV		
	HS-018 544	
<b>Varde, Keshav S.</b>		
A LASER INTERFEROMETER STUDY OF COM-		
BUSTION NEAR AN IGNITION SOURCE IN A STATIC		
CHAMBER		
	HS-018 593	
<b>Voas, Robert</b>		
A CRITIQUE OF THE PAPER "STATISTICAL		
EVALUATION OF THE EFFECTIVENESS OF AL-		
COHOL SAFETY ACTION"		
	HS-018 460	
THE PRO AND CON OF MOTORCYCLE HELMET		
LAWS. HELMET LAWS SAVE LIVES		
	HS-018 616	
<b>Volpi, E.</b>		
TEMPORARY ENGINE OIL VISCOSITY CHANGES AT		
HIGH TEMPERATURES		
	HS-018 545	
<b>Wade, R. A.</b>		
DESIGN CONCEPTS OF THE 400 SERIES SCRAPERS		
	HS-018 516	
<b>Wang, Bo Ping</b>		
LIMITING PERFORMANCE CHARACTERISTICS OF		
VEHICLE IMPACT SAFETY DEVICES		
	HS-018 560	
<b>Warner, D. B.</b>		
TIRE DESIGNS FOR MOBILITY--USSR		
	HS-018 493	
<b>Waschek, Arvid</b>		
EXPLOITING THE VERSATILITY OF A RADIAL		
PISTON PUMP		
	HS-018 524	
<b>Watkins, E. I.</b>		
APPLIED PHOTOELASTICITY FOR ENGINE COM-		
COMPONENT DESIGN ANALYSIS		
	HS-018 583	
<b>Weiner, S.</b>		
PAVEMENT FRICTION TEST TIRE CORRELATION.		
FINAL REPORT		
	HS-018 541	
<b>Welch, R. E.</b>		
FINITE ELEMENT ANALYSIS OF AUTOMOTIVE		
SHEET METAL UNDER IMPACT LOADING		
	HS-018 558	
<b>West, L. B.</b>		
THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.		
APPENDIX A. LITERATURE SUMMARY		
	HS-801 893	
<b>Whitehead, Paul C.</b>		
COLLISION BEHAVIOR OF YOUNG DRIVERS. A		
RESPONSE TO ZYLMAN		
	HS-018 611	
<b>Whitford, E. L.</b>		
FIELD TEST EXPERIENCE WITH NEW ELECTRONIC		
GOVERNOR		
	HS-018 499	

September 30, 1976

**Wierwille, Walter W.**

DRIVING SIMULATOR DESIGN FOR REALISTIC  
HANDLING

HS-018 554

**Wilde, G. J. S.**

TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A  
COMPARATIVE STUDY OF ASSESSMENT  
PROCEDURES

HS-018 513

**Willem, Edward F.**

SMALL BORE DIESEL ENGINE TESTING USING THE  
FRACTIONAL FACTORIAL TECHNIQUE TO EVALU-  
ATE OIL CONTROL

HS-018 498

**Willn, J. E.**

AN INVESTIGATION INTO PISTON RING SCUFFING  
DURING RUNNING-IN

HS-018 539

**Withjack, Eric M.**

STRATIFIED CHARGE ENGINES. FINAL REPORT  
HS-018 613

**Wong, J. P.**

A COMPARISON OF TIRE INFLUENCES ON VEHICLE  
HANDLING

HS-018 553

DIRECT AND INDIRECT METHODS FOR STABILITY  
STUDIES OF ARTICULATED VEHICLES

HS-018 549

**Woods, Donald L.**

REMEDIAL SAFETY TREATMENT OF NARROW  
BRIDGES

HS-018 565

**Woodside, M. B.**

THE NATIONAL HIGHWAY SAFETY NEEDS STUDY.  
APPENDIX A. LITERATURE SUMMARY

HS-801 893

**Wright, Paul H.**

PRIORITIES FOR ROADSIDE HAZARD MODIFICA-  
TION: A STUDY OF 300 FATAL ROADSIDE OBJECT  
CRASHES

HS-018 603

**Wykes, F. C.**

EUROPEAN PRACTICE IN RESPECT OF AUTOMO-  
TIVE CAMS AND FOLLOWERS

HS-018 578

**Zador, Paul**

STATISTICAL EVALUATION OF THE EFFECTIVE-  
NESS OF "ALCOHOL SAFETY ACTION PROJECTS"

HS-018 459

**Zellner, John W.**

OPTIMAL AERO-MECHANICAL DESIGN FOR SPE-  
CIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE  
SYSTEMS

HS-018 556

**Zylman, Richard**

COLLISION BEHAVIOR OF YOUNG DRIVERS. COM-  
MENT ON THE STUDY BY WHITEHEAD ET AL.

HS-018 615



## Corporate Author Index

Transport and Road Res. Lab., Road User Characteristics Div., Crowthorne, Berks., England		Barton-Aschman Associates, Inc., Ten Cedar Square West/Cedar-Riverside, 1610 South Sixth St., Minneapolis, Minn. 55404
DRIVER ERROR	HS-018 511	BICYCLING IN TENNESSEE. INVENTORY OF USERS, FACILITIES, AND PROGRAMS
Abex Corp.		HS-018 602
THE NATURE OF ABRASIVE WEAR	HS-018 530	
Abt Associates Inc.		British Technical Council of the Motor and Petroleum Industries
NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES ADMINISTRATIVE ADJUDICATION BUREAU	HS-018 491	AN INVESTIGATION INTO PISTON RING SCUFFING DURING RUNNING-IN
		HS-018 539
American Society of Mechanical Engineers		EUROPEAN PRACTICE IN RESPECT OF AUTOMOTIVE CAMS AND FOLLOWERS
INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974	HS-018 546	HS-018 578
Amoco Oil Co.		Bureau of Mines, Bartlesville Energy Res. Center, P. O. Box 1398, Bartlesville, Okla. 74003
ORI (OCTANE REQUIREMENT INCREASE) OF TODAY'S VEHICLES	HS-018 633	AMBIENT TEMPERATURE AND VEHICLE EMISSIONS. FINAL REPORT
		HS-018 564
Arizona Dept. of Transportation, Traffic Operations Services		Calspan Corp., Buffalo, N.Y. 14221
ANNUAL SPEED STUDY (ARIZONA)	HS-018 469	EXPERIMENTAL VALIDATION OF THE CALSPAN TIRE RESEARCH FACILITY. VOL. 1. FINAL REPORT
		HS-018 481
Army Fuels and Lubricants Res. Lab.		Catholic Univ. of America, 620 Michigan Ave., N.E., Washington, D.C.
APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS	HS-018 532	HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT
		HS-018 487
Army Mobility Equipment Command		Chicago Rawhide Mfg. Co.
HYDRAULIC RESERVOIR BREATHERS. HOW GOOD	HS-018 540	THE OPERATION OF ELASTOMERIC RADIAL LIP SEALS AT HIGH TEMPERATURES
		HS-018 528
Army Mobility Equipment Res. and Devel. Center		City of Phoenix Alcohol Safety Action Proj., ASAP Evaluation Unit, 251 West Washington St., Phoenix, Ariz. 85003
APPLICATION OF SYNTHETIC ENGINE OILS IN ARMY HYDRAULIC AND POWER TRANSMISSION FLUID SYSTEMS	HS-018 532	AN ANALYSIS OF TOTAL PROJECT IMPACT. (PHOENIX, ARIZONA, ALCOHOL SAFETY ACTION PROJECT). ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 1
		HS-801 886
Atlantic Richfield Co.		ANALYSIS OF ASAP PATROL ACTIVITY. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDY 3
PERFORMANCE CHARACTERISTICS OF STRATIFIED CHARGE VEHICLES WITH CONVENTIONAL FUELS AND GASOLINE BLENDED WITH ALCOHOL AND WATER	HS-018 635	HS-801 887
		ANALYSES OF DRINKER DIAGNOSIS AND REFERAL ACTIVITY AND ALCOHOL REHABILITATION EFFORTS. ANNUAL REPORT 1974. SECTION 2. ANALYTIC STUDIES 5 AND 6
		HS-801 888
ANACAPA Sciences, Inc.		City of Santa Barbara, California, Transportation Div. CHILDREN BICYCLISTS: SHOULD A MINIMUM AGE BE REQUIRED?
DRIVER EXPECTANCY AND PERFORMANCE IN LOCATING AUTOMOTIVE CONTROLS	HS-018 596	HS-018 465
AVL, Austria		Compagnie Francaise de Raffinage, France
EFFICIENT AND CLEAN DIESEL COMBUSTION	HS-018 519	FOUR STROKE MOTORCYCLE ENGINES A STUDY OF THEIR LUBRICATING OIL REQUIREMENTS
		HS-018 521
Barber-Colman Co., Precision Dynamics Div.		
FIELD TEST EXPERIENCE WITH NEW ELECTRONIC GOVERNOR	HS-018 499	

**Connecticut Motor Vehicle Dept., Wethersfield, Conn.  
06109**  
SNOWMOBILE HANDBOOK. LAWS AND REGULATIONS  
HS-018 506

**County of Los Angeles Alcohol Safety Action Proj.  
AN ANALYSIS OF ULTIMATE PERFORMANCE MEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**  
HS-801 877  
AN ANALYSIS OF THE ALCOHOLISM COUNCILS COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)  
HS-801 879

AN ANALYSIS OF LAW ENFORCEMENT COUNTERMEASURES: 1974. ANALYTIC STUDY FOR 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)  
HS-801 880

AN ANALYSIS OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)  
HS-801 881

AN ANALYSIS OF THE LOS ANGELES UNIFIED SCHOOL DISTRICT COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)  
HS-801 884

**County of Los Angeles Alcohol Safety Action Proj.  
AN ANALYSIS OF THE HOUSEHOLD SURVEY: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**  
HS-801 878

**County of Los Angeles Alcohol Safety Proj.  
AN ANALYSIS OF THE OCCUPATIONAL HEALTH SERVICE COUNTERMEASURE: FINAL REPORT (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)**  
HS-801 882

**Daimler-Benz AG (Germany)  
NEW METHODS FOR REDUCING VISIBLE EMISSIONS OF DIESEL ENGINES**  
HS-018 503

**Daimler-Benz AG (West Germany)  
DESIGN AND RESULTS OF THE FIVE-CYLINDER MERCEDES-BENZ DIESEL ENGINE**  
HS-018 581

**Deere and Co.  
EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP**  
HS-018 524

**Department of the Environment, St. Christopher House, London, SE1 OTE, U.K.  
THE APPLICATION OF AN ELECTROVISCOSUS DAMPER TO A VEHICLE SUSPENSION SYSTEM**  
HS-018 551

**Department of Motor Transport, Traffic Accident Res. Unit, New South Wales, Australia  
ALCOHOL, DRUGS AND ACCIDENT RISK**  
HS-018 604

**Department of Transportation  
STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT**  
HS-018 464

**Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142  
SERVICE AND METHODS DEMONSTRATION (URBAN TRANSPORTATION). ANNUAL REPORT**  
HS-018 484

**STRATIFIED CHARGE ENGINES. FINAL REPORT**  
HS-018 613

**Department of Transportation, Washington, D. C. 20590  
THE NATIONAL HIGHWAY SAFETY NEEDS REPORT. REPORT OF THE SECRETARY OF TRANSPORTATION TO THE UNITED STATES CONGRESS PURSUANT TO SECTION 225 OF THE HIGHWAY SAFETY ACT OF 1973**  
HS-801 892

**Deutsche BP Aktiengesellschaft  
MULTI-PURPOSE ENGINE LUBRICANT FOR MIXED FLEET OPERATION**  
HS-018 522

**Dickey-john Corp.  
WHAT ARE THE BENEFITS OF MONITORING? (ELECTRONIC MONITORING EQUIPMENT FOR AGRICULTURAL USE)**  
HS-018 529

**Environmental Protection Agency  
EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT**  
HS-018 520

**STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. TECHNOLOGY PANEL REPORT**  
HS-018 464

**Essotech (Italy)  
LOW TEMPERATURE VISCOSITY REQUIREMENTS OF THE ITALIAN CAR POPULATION**  
HS-018 577

**Ethyl Corp., Res. Labs.  
ONE HUNDRED YEARS OF THE OTTO-CYCLE ENGINE**  
HS-018 601

**Federal Hwy. Administration  
FATAL AND INJURY ACCIDENT RATES ON FEDERAL-AID AND OTHER HIGHWAY SYSTEMS/1974**  
HS-018 570

**ROADSIDE SAFETY DESIGN**  
HS-018 480

**1976 DRIVER LICENSE ADMINISTRATION REQUIREMENTS AND FEES**  
HS-018 561

September 30, 1976

**Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20590**  
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE, 1971  
HS-018 605

**Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20591**  
SELECTED SAFETY ROAD CHECKS. MOTOR CARRIERS OF PROPERTY. 1970  
HS-018 606

**Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20590**  
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JULY THROUGH DECEMBER 1972  
HS-018 608

**Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590**  
SAFETY ROAD CHECKS, MOTOR CARRIERS OF PROPERTY. JANUARY THROUGH JUNE 1973  
HS-018 609

**Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D. C. 20590**  
MOTOR CARRIER ACCIDENT INVESTIGATION. A. V. JACKSON ACCIDENT--JUNE 13, 1975--INDIANAPOLIS, INDIANA  
HS-018 612

**Federal Hwy. Administration, Offices of Res. and Devel., Washington, D.C. 20590**  
PAVEMENT FRICTION TEST TIRE CORRELATION. FINAL REPORT  
HS-018 541

**Federal Hwy. Administration, Traffic Systems Div., Washington, D.C. 20590**  
HUMAN FACTOR REVIEW OF TRAFFIC CONTROL AND DIVERSION PROJECTS. FINAL REPORT  
HS-018 487

**Federal Republic of Germany Armed Forces**  
HYDRAULIC RESERVOIR BREATHERS. HOW GOOD  
HS-018 540

**Fiat S.p.A.**  
A NEW DIESEL INJECTION PUMP WITH HIGH INJECTION RATE, ITS INFLUENCE ON SMOKE AND EMISSIONS  
HS-018 515

**Fiat, Italy**  
TEMPORARY ENGINE OIL VISCOSITY CHANGES AT HIGH TEMPERATURES  
HS-018 545

**Ford of Britain, Technological Res.**  
OCCUPANT PROTECTION IN VEHICLE ROLLOVER  
HS-018 483

**Ford Motor Co.**  
APPLIED PHOTOELASTICITY FOR ENGINE COMPONENT DESIGN ANALYSIS  
HS-018 583  
LABORATORY EVALUATION OF THREE-WAY CATALYSTS  
HS-018 639

**Ford Motor Co., Engineering and Res. Staff**  
CHARACTERIZATION OF ZIRCONIA AND TITANIA ENGINE EXHAUST GAS SENSORS FOR AIR/FUEL FEEDBACK CONTROL SYSTEMS  
HS-018 640

MORE DATA ON ORI (OCTANE REQUIREMENT INCREASE) VARIABLES  
HS-018 634

**Gakushuin Univ. (Japan)**  
INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS  
HS-018 585

**General Motors Corp., Res. Labs.**  
VEHICLE EVALUATION OF SYNTHETIC AND CONVENTIONAL ENGINE OILS  
HS-018 531

**General Motors, Res. Labs.**  
THE STAGED COMBUSTION COMPOUND ENGINE (SCCE): EXHAUST EMISSIONS AND FUEL ECONOMY POTENTIAL  
HS-018 622

**Georgia Inst. of Tech.**  
PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES  
HS-018 603

**Gulf Res. Laboratoria B.V. (Netherlands)**  
EUROPEAN VALVE TRAIN WEAR--SOME EXPERIENCE WITH THE VOLVO B20 TEST  
HS-018 579

**Hennepin County Alcohol Safety Action Proj., Hennepin County, Minn.**  
AN ANALYSIS OF ALCOHOL REHABILITATION EFFORTS. ANALYTIC STUDY NO. 6  
HS-801 885

**Institut Francais du Petrole (France)**  
EUROPEAN OILS FOR SPARK IGNITION ENGINES  
HS-018 566

**Institute for Road Safety Res. SWOV, P. O. Box 71, Deernsstraat 1, Voorburg 2119, The Netherlands**  
SAFETY OF PEDESTRIAN CROSSING FACILITIES  
HS-018 594

**Insurance Inst. for Hwy. Safety, Watergate Six Hundred, Washington, D. C. 20037**  
PRIORITIES FOR ROADSIDE HAZARD MODIFICATION: A STUDY OF 300 FATAL ROADSIDE OBJECT CRASHES  
HS-018 603

**Insurance Inst. for Hwy. Safety, Watergate 600, Washington, D.C. 20037**  
ESTIMATES OF MOTOR VEHICLE SEAT BELT EFFECTIVENESS AND USE: IMPLICATIONS FOR OCCUPANT CRASH PROTECTION  
HS-018 509

**International Harvester Co., Pay Line Div.**  
DESIGN CONCEPTS OF THE 400 SERIES SCRAPERS  
HS-018 516

IIT Res. Inst., Chicago, Ill.	Mitsubishi Motors Corp. (Japan)
FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING	NOX (OXIDES OF NITROGEN) CATALYTIC CONVERTER DEVELOPMENT
HS-018 558	HS-018 637
<b>John Deere Waterloo Tractor Works</b>	<b>Mobil R and D Corp.</b>
EXPLOITING THE VERSATILITY OF A RADIAL PISTON PUMP	THE EFFECTS OF ENGINE VARIABLES AND EXHAUST GAS RECIRCULATION ON EMISSIONS, FUEL ECONOMY, AND KNOCK--PART 2
HS-018 524	HS-018 636
<b>Koppers Co., Inc.</b>	<b>MIT, Dept. of Aeronautics and Astronautics, Cambridge, Mass. 02139</b>
SMALL BORE DIESEL ENGINE TESTING USING THE FRACTIONAL FACTORIAL TECHNIQUE TO EVALUATE OIL CONTROL	LOOK AHEAD STEERING STRATEGY
HS-018 498	HS-018 555
<b>Kyoto Univ., Dept. of Mechanical Engineering, Japan</b>	<b>National Hwy. Traffic Safety Administration, Washington, D. C. 20590</b>
PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE	MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS. OCTOBER 1, 1975 TO DECEMBER 31, 1975. DETAILED REPORTS
HS-018 518	HS-801 848
<b>Liikenneturva, Central Organization for Traffic Safety, Res. Dept., Iso Roobertinkatu 20, 00120 Helsinki 12 Finland</b>	<b>National Inst. of Law Enforcement and Criminal Justice, Washington, D.C. 20531</b>
INVESTIGATIONS INTO LIGHT TRAFFIC 2	NILECJ (NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE) STANDARD FOR CRASH HELMETS
HS-018 495	HS-018 508
<b>Los Angeles County Alcohol Safety Action Proj.</b>	<b>National Res. Council, National Materials Advisory Board, 2101 Constitution Ave., N. W., Washington, D. C. 20418</b>
AN ANALYSIS OF THE MINI-ASAP REHABILITATION COUNTERMEASURES: 1974 (LOS ANGELES COUNTY ALCOHOL SAFETY ACTION PROJECT)	AEROSPACE STRUCTURAL ADHESIVES. FINAL REPORT
HS-801 883	HS-018 473
<b>Loughborough Univ. of Technology, Dept. of Mechanical Engineering, United Kingdom</b>	<b>National Swedish Road and Traffic Res. Inst., (Statens Vaeg-och Trafikinstitut) Fack 581 01 Linkoping, Sweden</b>
THE MEASUREMENT OF THE TURBULENCE CHARACTERISTICS IN AN INTERNAL COMBUSTION ENGINE CYLINDER	EFFECTS OF SMALL DOSES OF ALCOHOL ON DRIVER PERFORMANCE IN EMERGENCY TRAFFIC SITUATIONS
HS-018 588	HS-018 468
<b>Loughborough Univ. of Technology, England</b>	<b>New York State Dept. of Motor Vehicles, Administrative Adjudication Bureau</b>
TURBULENT FLOW IN SPARK IGNITION ENGINE COMBUSTION CHAMBERS	HANDLING TRAFFIC CASES: A BETTER WAY
HS-018 587	HS-018 490
<b>Ministry of Defence, United Kingdom</b>	<b>Nissan Motor Co., Ltd. (Japan)</b>
EXPERIENCES WITH MULTIGRADE HEAVY DUTY ENGINE OILS IN MILITARY GASOLINE AND DIESEL ENGINES	COMPARISON OF AUTOMOTIVE CATALYTIC HONEYCOMB STRUCTURES THROUGH TWO-DIMENSIONAL THERMAL STRESS ANALYSIS
HS-018 523	HS-018 582
<b>Ministry of Transport, Motor Vehicle Traffic Safety Branch, Ottawa, Ont., Canada</b>	STUDY OF NH <sub>3</sub> (AMMONIA) FORMATION AND ITS CONTROL IN THE NOX (OXIDES OF NITROGEN) CATALYST SYSTEM
A REVIEW OF THREE STUDIES ATTEMPTING TO RELATE REPORTED SEAT BELT USAGE TO SEAT BELT ATTITUDES AND OTHER VARIABLES	HS-018 638
HS-018 592	
<b>Ministry of Transport, Road and Motor Vehicle Traffic Safety Branch, Ottawa, Ont., Canada</b>	<b>Office of Population Censuses and Surveys, Social Survey Div.</b>
BLOOD ALCOHOL LEVELS OF NIGHTTIME CANADIAN DRIVERS. INTERIM REPORT	CHILDREN AND ROAD SAFETY: A SURVEY AMONGST MOTHERS
HS-018 486	HS-018 597
<b>Ministry of Transport, Road Safety Unit</b>	<b>Oklahoma State Univ., Fluid Power Res. Center</b>
DAYTIME RUNNING LIGHTS PROJECT. 2. VEHICLE DETECTION AS A FUNCTION OF HEADLIGHT USE AND AMBIENT ILLUMINATION	FILTER SELECTION BASED ON COMPONENT SENSITIVITY ANALYSIS
HS-018 593	HS-018 535

September 30, 1976

LUBE OIL FILTER EVALUATION	HS-018 533	Road Traffic Authority, Res. and Statistics Section, 22
THE EFFECT OF BY-PASS VALVE LEAKAGE ON FILTER PERFORMANCE	HS-018 534	Mount St., Perth, W.A. 6000 Australia AN INVESTIGATION TO DETERMINE WHETHER BLOOD ALCOHOL TESTS SHOULD BE COMPULSORY FOR ALL TRAFFIC ACCIDENT CASUALTIES OVER THE AGE OF 15 YEARS ADMITTED TO HOSPITAL IN WESTERN AUSTRALIA
Parker-Hannifin Corp., Parker Seal Group WHAT'S NEW WITH SEALS?	HS-018 538	HS-018 629
Peter Ward Associates (Interplan) Ltd., 9-15 London Rd., Croydon, CRO 2RE England AUTOMOTIVE DIAGNOSTIC AND REPAIR EQUIPMENT	HS-018 631	Road Traffic Authority, Res. and Statistics Section, 22 Mount St., Perth, W.A., 6000 Australia AN INVESTIGATION TO DETERMINE WHETHER THE DAYTIME USAGE OF MOTORCYCLE HEADLIGHTS AND TAILLIGHTS SHOULD BE MADE COMPULSORY IN WESTERN AUSTRALIA
Porsche (West Germany) COMBUSTION AND EXHAUST EMISSION OF AN ENGINE USING THE PORSCHE-STRATIFIED-CHARGE-CHAMBER-SYSTEM	HS-018 590	HS-018 630
Princeton Univ., Princeton, N. J. SCHEDULING DELAYS IN SYNCHRONOUS TRANSPORTATION NETWORKS	HS-018 550	Rohr Industries, Inc. TRANSBUS--TESTING AND PUBLIC EVALUATION (AROUND THE COUNTRY IN 80 DAYS)
Queen's Univ., Dept. of Psychology, Kingston, Ont., Canada TASK LOAD IN THE MOTOR VEHICLE OPERATOR: A COMPARATIVE STUDY OF ASSESSMENT PROCEDURES	HS-018 513	HS-018 461
Raybestos-Manhattan, Inc., Stratford Div. EFFECT OF FLUID TEMPERATURE ON THE PERFORMANCE OF FRICTION MATERIAL	HS-018 527	Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096 ENERGY AND TRANSPORTATION
Rensselaer Polytechnic Inst., Troy, N.Y. OPTIMAL AERO-MECHANICAL DESIGN FOR SPECIALIZED MAN-IN-THE-LOOP DRIVER-VEHICLE SYSTEMS	HS-018 556	HS-018 595 INTER-INDUSTRY EMISSION CONTROL PROGRAM 2 (IIEC-2) PROGRAM REPORT NO. 2
TECHNIQUES FOR OBTAINING IMPROVEMENTS IN THE HANDLING QUALITIES AND PERFORMANCE OF A SUBMERGED VEHICLE	HS-018 557	HS-018 632
Research Triangle Inst., Raleigh, N.C. THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX A: LITERATURE SUMMARY	HS-801 893	Southwest Res. Inst. EXHAUST EMISSIONS FROM FARM, CONSTRUCTION, AND INDUSTRIAL ENGINES AND THEIR IMPACT
THE NATIONAL HIGHWAY SAFETY NEEDS STUDY. APPENDIX B: COUNTERMEASURES EVALUATED. APPENDIX C: ADVISORY PANEL FINDINGS. APPENDIX D: STATE SURVEYS	HS-801 894	HS-018 520
Ricardo and Co. Engineers (1927) Ltd. A FUNDAMENTAL INVESTIGATION INTO THE PROBLEM OF NO (NITRIC OXIDE) FORMATION IN DIESEL ENGINES	HS-018 536	Sundstrand Corp., Sundstrand Hydro-Transmission Div. CONTROLLING VARIABLE DISPLACEMENT HYDRAULIC PUMPS FOR ENERGY CONSERVATION
Rion Co., Ltd. (Japan) INDISCOPE--A NEW COMBUSTION PRESSURE INDICATOR WITH WASHER TRANSDUCERS	HS-018 585	HS-018 526
		T.R.W. Inc., T.R.W. Piston Ring Div. NEW DEVELOPMENTS IN PISTON RINGS FOR THE MODERN DISEASE ENGINE
		HS-018 494
		Technische Universitat Braunschweig, Institut fur Fahrzeugtechnik OSCILLATORY INSTABILITY OF A TRACTOR-SEMITRAILER VEHICLE--A CASE STUDY
		HS-018 547
		Technische Universitat, Institut fur Fahrzeugtechnik SIMULATION OF VEHICLE BRAKING WITH ANTI-LOCK DEVICES
		HS-018 552
		The University of Sheffield, Dept. of Mechanical Engineering, S1 3JD, U.K. THE APPLICATION OF AN ELECTROVISCOUS DAMPER TO A VEHICLE SUSPENSION SYSTEM
		HS-018 551
		Transit Devel. Corp., Inc., 1730 M St., N.W., Washington, D. C. 20036 ACCIDENT SOURCE COMPILATION. FINAL REPORT
		HS-018 467

transport and Road Res. Lab., Road User Characteristics Div., Crowthorne, Berks., England RISK TAKING AS A DECISION PROCESS IN DRIVING	HS-018 512	RESPONSE OF NAIVE DRIVERS TO PRESENCE AND STOP SIGNALS OF EXPERIMENTAL REAR LIGHTING CONFIGURATIONS	HS-018 477
transportation Res. Board, National Res. Council, Washington, D.C. EFFECTS OF STUDDED TIRES	HS-018 614	PERCEPTION OF RELATIVE VELOCITY	HS-018 478
University of Colorado, Dept. of Electrical Engineering, Boulder, Colo. PRACTICAL OPERATION AND TESTING OF AN URBAN ELECTRIC VEHICLE	HS-018 559	University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. PARAMETER STUDY OF THE STABILITY OF AN AR- TICULATED VEHICLE IN FIVE DEGREES OF FREEDOM	HS-018 548
University of Detroit CORRECTION FACTOR TO UNIT CORE HEAT TRANSFER CAPABILITY OF HEAT EXCHANGER CORE DUE TO VARIATION OF TUBE LENGTH	HS-018 586	University of Virginia, Dept. of Engineering Science and Systems, Charlottesville, Va. 22901 LIMITING PERFORMANCE CHARACTERISTICS OF VEHICLE IMPACT SAFETY DEVICES	HS-018 560
University of Illinois at Chicago, Dept. of Engineering FINITE ELEMENT ANALYSIS OF AUTOMOTIVE SHEET METAL UNDER IMPACT LOADING	HS-018 558	Urban Inst., 2100 M St., N.W., Washington, D.C. 20037 INDUSTRIAL AND ECONOMIC IMPACTS OF IMPROV- ING AUTOMOBILE FUEL EFFICIENCY: AN INPUT- OUTPUT ANALYSIS	HS-018 507
University of Louisville, Dept. of Mechanical Engineering, Louisville, Ky. A COMPARISON OF TIRE INFLUENCES ON VEHICLE HANDLING	HS-018 553	Virginia Polytechnic Inst. and State Univ. at Blacksburg, Va. INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974	HS-018 546
University of Louisville, Mechanical Engineering Dept., Louisville, Ky. DIRECT AND INDIRECT METHODS FOR STABILITY STUDIES OF ARTICULATED VEHICLES	HS-018 549	Virginia Polytechnic Inst. and State Univ., Blacksburg, Va. 24060 DRIVING SIMULATOR DESIGN FOR REALISTIC HANDLING	HS-018 554
University of Maryland, Transportation Studies Center, College Park, Md. 20742 IDENTIFICATION AND PROGRAMMING OF ROAD- SIDE HAZARD IMPROVEMENTS. INTERIM REPORT	HS-018 462	Volkswagenwerk A AG (West Germany) CALCULATION OF A DYNAMICALLY AND ECCEN- TRICALLY LOADED BOLTED CONROD CONNEC- TION ACCORDING TO VDI 2230	HS-018 584
University of Michigan, Dearborn A LASER INTERFEROMETER STUDY OF COM- BUSTION NEAR AN IGNITION SOURCE IN A STATIC CHAMBER	HS-018 589	Volkswagenwerk AG, Res. and Devel. (West Germany) THE WATER-COOLED VOLKSWAGEN PCI- STRATIFIED CHARGE ENGINE	HS-018 580
University of Michigan, Hwy. Safety Res. Inst. AN EVALUATION OF THE 1974 RESTRAINT SYSTEMS. EXECUTIVE SUMMARY	HS-018 510	Wayne State Univ. CHARACTERIZATION AND SIMULATION OF A UNIT INJECTOR	HS-018 514
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109 STUDIES OF AUTOMOBILE AND TRUCK REAR LIGHTING AND SIGNALING SYSTEMS. FINAL RE- PORT	HS-018 474	INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD) PROCEEDINGS, BLACKSBURG, VIRGINIA, AUG. 12-15, 1974	HS-018 546
ACCIDENT DATA ANALYSIS	HS-018 475	White Motor Corp. HEAVY-DUTY TRUCK SUSPENSIONS	HS-018 600
INTERPRETATION OF SIGNALS (VEHICLE REAR LIGHTING)	HS-018 476	Yokohama National Univ., Dept. of Mechanical Engineering, Japan PREDICTION OF RADIATIVE HEAT FLUX IN A DIESEL ENGINE	HS-018 518

# Contract Number Index

**AW-75-148-46**

University of Maryland, Transportation Studies Center, College Park, Md. 20742

HS-018 462

New York State Dept. of Motor Vehicles, Administrative Adjudication Bureau

HS-018 490

**CON-2598-SV**

Ford of Britain, Technological Res.

HS-018 483

**MDA-903-74-C-0167**

National Res. Council, National Materials Advisory Board, 2101 Constitution Ave., N. W., Washington, D. C. 20418

HS-018 473

**DOT-HS-048-1-064**

Hennepin County Alcohol Safety Action Proj., Hennepin County, Minn.

HS-801 885

**NGR-47-005-145**

University of Virginia, Dept. of Engineering Science and Systems, Charlottesville, Va. 22901

HS-018 560

**DOT-HS-052-1-068**

City of Phoenix Alcohol Safety Action Proj., ASAP Evaluation Unit, 251 West Washington St., Phoenix, Ariz. 85003

HS-801 886

**NSF-G1-40615**

Urban Inst., 2100 M St., N.W., Washington, D.C. 20037

HS-018 507

**City of Phoenix Alcohol Safety Action Proj., ASAP Evaluation Unit, 251 West Washington St., Phoenix, Ariz. 85003**

HS-801 887

**UM-7101-C128**

University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48109

HS-018 474

City of Phoenix Alcohol Safety Action Proj., ASAP Evaluation Unit, 251 West Washington St., Phoenix, Ariz. 85003

HS-801 888

**14.1**

ANACAPPA Sciences, Inc.

HS-018 596

**DOT-HS-161-2-252 Grant NIH-RR-3.**

County of Los Angeles Alcohol Safety Action Proj.

HS-801 877

County of Los Angeles Alcohol Safety Action Proj.

HS-801 878

County of Los Angeles Alcohol Safety Action Proj.

HS-801 879

County of Los Angeles Alcohol Safety Action Proj.

HS-801 880

County of Los Angeles Alcohol Safety Action Proj.

HS-801 881

County of Los Angeles Alcohol Safety Proj.

HS-801 882

County of Los Angeles Alcohol Safety Action Proj.

HS-801 884

Los Angeles County Alcohol Safety Action Proj.

HS-801 883

**DOT-HS-5-01069**

Research Triangle Inst., Raleigh, N.C.

HS-801 893

**DOT-HS-5-10169**

Research Triangle Inst., Raleigh, N.C.

HS-801 894

**EHS-70-108**

Southwest Res. Inst.; Environmental Protection Agency

HS-018 520

**FH-11-8001**

Federal Hwy. Administration, Traffic Systems Div., Washington, D.C. 20590; Catholic Univ. of America, 620 Michigan Ave., N.E., Washington, D.C.

HS-018 487

**J-LEAA-014-74**

Abt Associates Inc.

HS-018 491



## Report Number Index

<b>AD-787 040</b>		<b>SAE-SP-403</b>	
	HS-018 473		HS-018 632
<b>AR-8</b>		<b>SAE-SP-405</b>	
	HS-018 570		HS-018 601
<b>BMCS-75-5</b>		<b>SAE-SP-406</b>	
	HS-018 612		HS-018 595
<b>CAL-7309-C235</b>		<b>SAE-SP-407</b>	
	HS-018 481		HS-018 596
<b>CR-7503</b>		<b>SAE-750735</b>	
	HS-018 592		HS-018 461
<b>CR-7504</b>		<b>SAE-750769</b>	
	HS-018 513		HS-018 494
<b>DIB-75-12-507</b>		<b>SAE-750770</b>	
	HS-018 631		HS-018 498
<b>DOT-TSC-OST-75-56</b>		<b>SAE-750771</b>	
	HS-018 613		HS-018 499
<b>DOT-TSC-UMTA-76-1</b>		<b>SAE-750772</b>	
	HS-018 484		HS-018 503
<b>EPA-460/3-74-028</b>		<b>SAE-750773</b>	
	HS-018 564		HS-018 514
<b>FHWA-MD-R-76-2</b>		<b>SAE-750774</b>	
	HS-018 462		HS-018 515
<b>FHWA-RD-74-22</b>		<b>SAE-750779</b>	
	HS-018 487		HS-018 516
<b>FHWA-RD-75-88</b>		<b>SAE-750786</b>	
	HS-018 541		HS-018 518
<b>HCASAP-5/30/75</b>		<b>SAE-750787</b>	
	HS-801 885		HS-018 519
<b>ISSN-0305-1315</b>		<b>SAE-750788</b>	
	HS-018 511		HS-018 520
<b>Liikenneturva-18</b>		<b>SAE-750789</b>	
	HS-018 495		HS-018 521
<b>NCHRP-Synthesis-32</b>		<b>SAE-750790</b>	
	HS-018 614		HS-018 522
<b>NILECJ-STD-015.00</b>		<b>SAE-750791</b>	
	HS-018 508		HS-018 523
<b>NMAB-300</b>		<b>SAE-750805</b>	
	HS-018 473		HS-018 524
<b>Pub-1974-2E</b>		<b>SAE-750806</b>	
	HS-018 594		HS-018 525
<b>PB-246 246</b>		<b>SAE-750807</b>	
	HS-018 467		HS-018 526
<b>PB-247 692</b>		<b>SAE-750809</b>	
	HS-018 564		HS-018 527
<b>RSU-75/2</b>		<b>SAE-750810</b>	
	HS-018 593		HS-018 528
<b>SAE-SP-402</b>		<b>SAE-750812</b>	
	HS-018 600		HS-018 529

SAE-750822		SAE-750887	
	HS-018 530		HS-018 589
SAE-750827		SAE-750888	
	HS-018 531		HS-018 590
SAE-750828		SAE-750889	
	HS-018 532		HS-018 622
SAE-750845		SAE-760001	
	HS-018 533		HS-018 601
SAE-750846		SAE-760195	
	HS-018 534		HS-018 633
SAE-750847		SAE-760196	
	HS-018 535		HS-018 634
SAE-750848		SAE-760197	
	HS-018 536		HS-018 635
SAE-750851		SAE-760198	
	HS-018 537		HS-018 636
SAE-750852		SAE-760199	
	HS-018 538		HS-018 637
SAE-750853		SAE-760200	
	HS-018 540		HS-018 638
SAE-750861		SAE-760201	
	HS-018 539		HS-018 639
SAE-750862		SAE-760202	
	HS-018 545		HS-018 640
SAE-750863		SAE-760369	
	HS-018 566		HS-018 600
SAE-750864		SS450	
	HS-018 577		HS-018 597
SAE-750865		Technology-Panel-4	
	HS-018 578		HS-018 464
SAE-750866		TDC-500-75-9	
	HS-018 579		HS-018 467
SAE-750869		TRRL-SR-149-UC	
	HS-018 580		HS-018 511
SAE-750870		TRRL-SR-81-UC	
	HS-018 581		HS-018 512
SAE-750872		UM-HSRI-HE-74-25	
	HS-018 582		HS-018 474
SAE-750881		UMTA-MA-06-0049-75-2	
	HS-018 583		HS-018 484
SAE-750882		Working-Paper-1216-3-2	
	HS-018 584		HS-018 507
SAE-750883		ZM-5269-K-1	
	HS-018 585		HS-018 481
SAE-750884		26U-1090-13	
	HS-018 586		HS-801 893
SAE-750885		4/75	HS-801 894
SAE-750886	HS-018 587		HS-018 604

September 30, 1976

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